KEYS
to
SOIL TAXONOMY

by

SOIL SURVEY STAFF

Agency for International Development
United States Department of Agriculture
Soil Management Support Services

SMSS Technical Monograph No. 19
Fourth Edition, 1990

Virginia Polytechnic Institute
and State University

KEYS TO SOIL TAXONOMY

BY

SOIL SURVEY STAFF

Agency for International Development
United States Department of Agriculture
Soil Management Support Services

SMSS Technical Monograph No. 19

Virginia Polytechnic Institute
and State University

KEYS TO SOIL TAXONOMY

Prepared by Crop and Soil Environmental Sciences
Department
Virginia Polytechnic Institute
and State University
Blacksburg, Virginia

For

THE SOIL MANAGEMENT SUPPORT SERVICES

Soil Management Support Services is a program of international technical assistance in soil survey, classification, interpretation, and use and management of soils in the intertropical countries of the Agency for International Development implemented by the Soil Conservation Service of the United States Department of Agriculture under PASA No. AG/DSB-1129-5-79.

This publication was produced under a cooperative agreement between the Soil Management Support Services (SMSS) and Virginia Tech's *University Relations* and Crop and Soil Environmental Sciences department s from funding by the Agency for International Development (A.I.D.).

The contents of this publication were provided by the Soil Conservation Service (SCS). Staff of Virginia Tech's Publication Unit prepared the camera-ready manscript from text-files provided by SCS.

To obtain additional copies in developing countries:

Ask your AID country mission or write to:
SMSS Program Leader
Soil Conservation Service
U. S. Department of Agriculture
P. O. Box 2890
Washington, DC 20013

To obtain additional copies in the USA and developed countries write to:
International Soils
Department of Crop and Soil Environmental Sciences
Virginia Tech
Blacksburg, Virginia 24061-0404

U.S. and developed countries' requests should include a check for $12.00 in US dollars per copy made out to the Crop and Soil Environmental Sciences Department, Virginia Tech.

Citation:
Soil Survey Staff. 1990. Keys to Soil Taxonomy, fourth edition. SMSS technical monograph no. 6. Blacksburg, Virginia.

Fourth Edition
1990

ISBN 0-929900-01-4

TABLE OF CONTENTS

Chapter 1: The Soil That We Classify and Horizons and Properties Diagnostic for the Higher Categories: Mineral Soils 1

Chapter 2: Horizons and Properties Diagnostic for the Higher Categories: Organic Soils. 39

Chapter 3: Family Differentiae 45

Table 1. Key to Mineralogy Classes 63

Table 2. Key to Mineralogy Classes of Oxisols 66

Chapter 4: Identification of the Taxonomic Class of a Soil 67

Chapter 5: Alfisols 73

Chapter 6: Andisols 129

Chapter 7: Aridisols 159

Chapter 8: Entisols 195

Chapter 9: Histosols 225

Chapter 10: Inceptisols 241

Chapter 11: Mollisols 275

Chapter 12: Oxisols 335

Chapter 13: Spodosols 357

Chapter 14: Ultisols .... 3~~9~~73

Chapter 15: Vertisols 407

SI Units Conversion Table 412

Designations for Horizons and Layers 413

Textural Triangle .... Inside back cover

surface mantle should not be based solely on studies of associated soils.

MINERAL SOIL MATERIAL

Mineral soil material *either*

1. Is never saturated with water for more than a few days and has less than 20 percent organic carbon by weight; *or*

2. Is saturated with water for long periods or has been artificially drained, and has

   a. Less than 18 percent organic carbon by weight if 60 percent or more of the mineral fraction is clay; *or*

   b. Less than 12 percent organic carbon by weight if the mineral fraction has no clay; *or*

   c. A proportional content of organic carbon between 12 and 18 percent if the clay content of the mineral fraction is between zero and 60 percent.

Soil material that has more organic carbon than the amounts just given is considered to be organic material.

DEFINITION OF MINERAL SOILS

Mineral soils, in this taxonomy, are soils that meet one of the following requirements:

1. Mineral soil material less than 2.0 mm in diameter (the fine-earth fraction) makes up more than half the thickness of the upper 80 cm (31 in.); *or*

2. The depth to bedrock is less than 40 cm and the layer or layers of mineral soil directly above the rock either are 10 cm or more thick or have half or more of the thickness of the overlying organic soil material; *or*

3. The depth to bedrock is 40 cm or more, the mineral soil material immediately above the bedrock is 10 cm or more thick, and *either*

   a. Organic soil material is less than 40 cm thick and is decomposed (consisting of hemic or sapric materials as defined later) or has a bulk density of 0.1 or more; *or*

   b. Organic soil material is less than 60 cm thick and either is undecomposed sphagnum or moss fibers or has a bulk density that is less than 0.1.

DIAGNOSTIC SURFACE HORIZONS; THE EPIPEDON

Seven diagnostic horizons that form at the surface are defined. Any horizon, however, may be at the surface of a truncated soil. A horizon that forms at the surface is called an epipedon (Gr. *epi*, over or upon, and *pedon*, soil). The epipedon not only has formed at the surface but it also has been either appreciably darkened by organic matter or eluviated or, as a minimum, rock structure has been destroyed. Such a horizon may become covered by thin deposits of fresh alluvium or by thin eolian deposits without losing its identity as an epipedon. The depth to which an epipedon must be buried to be considered part of a buried soil is defined below. Generally a buried horizon lies below a depth of 50 cm or more, usually more.

There can be only one epipedon formed in the mineral surface horizon(s) of a soil. This epipedon may be overlain by organic materials that may meet the definition of a histic epipedon (defined later). Otherwise one soil may contain only one epipedon.

A recent alluvial or eolian deposit that retains fine stratifications or an Ap horizon that is directly underlain by material that retains fine stratifications is not included in the concept of the epipedon because time has not been sufficient for soil-forming processes to erase these transient marks of deposition and for diagnostic and accessory properties to develop.

The epipedon is not a synonym for the A horizon because it may include part or all of the illuvial B horizon if the darkening by organic matter extends from the surface into or through the B horizon. To avoid changes in classification of a soil as the result of plowing, the properties of the epipedon, except for structure, should be determined after the surface soil to a depth of 18 cm has been mixed or, if the depth to bedrock is less than 18 cm, after the whole soil down to rock has been mixed.

Anthropic epipedon

In summary, the anthropic epipedon conforms to all the requirements of the mollic epipedon except (1) the limits on acid-soluble P_2O_5, with or without the base saturation, or (2) the length of the period during which it has available moisture. Additional data on anthropic epipedons from several parts of the world may permit improvements in this definition.

Histic epipedon (Gr. *histos*, tissue)

The histic epipedon normally is at the surface, although it may be buried at a shallow depth. It normally is a thin horizon of peat or muck if the soil has not been plowed. If the soil has been plowed, the histic epipedon has the very high content of organic matter that results from mixing peat with some mineral material. Since peaty deposits occur in wet places, the histic epipedon either is saturated with water for 30 consecutive days or more during the year or has been artificially drained.

The histic epipedon, therefore, can be defined as a layer (one horizon or more) at or near the surface that is saturated with water for 30 consecutive days or more at some time in most years, or is artificially drained, and that meets one of the following requirements:

1. The surface horizon consists of organic soil material that *either*

a. Is 75 percent or more, by volume, sphagnum fibers or has a bulk density, when moist, of less than 0.1 and is less than 60 cm (24 in.) but more than 20 cm thick; *or*

b. Is less than 40 cm but more than 20 cm thick and meets one of the following requirements with respect to organic-carbon content and thickness:

(1) Has 18 percent or more organic carbon if the mineral fraction is 60 percent or more clay; *or*

(2) Has 12 percent or more organic carbon if the mineral fraction has no clay; *or*

(3) Has an intermediate proportional content of organic carbon if part but less than 60 percent of the mineral fraction is clay.

2. The plow layer is 25 cm or more thick and has 8 percent or more organic carbon if it has no clay, or 16 percent or more organic carbon if 60 percent or more of the mineral fraction is clay, or an intermediate proportional content of organic carbon if part but less than 60 percent of the mineral fraction is clay.

3. A layer of organic material that has enough organic carbon and is thick enough to satisfy one of the requirements under item 1 lies beneath a surface layer of mineral materials that is less than 40 cm (16 in.) thick. In such a soil, the histic epipedon has been buried but the mineral materials at the surface are too thin to be considered diagnostic in the classification.

4. A surface layer of organic material less than 25 cm thick that has enough organic carbon to satisfy the minimum requirements under item 2 after the soil has been mixed to a depth of 25 cm.

Mollic epipedon (L. *mollis*, soft)

The mollic epipedon is defined in terms of its morphology rather than its genesis. It consists of mineral soil material. It is a surface horizon or horizons unless (a) it underlies a recent deposit that is less than 50 cm thick and that has fine stratifications if not plowed or (b) it underlies a thin layer of organic material in a wet soil (see histic epipedon). If the layer of organic material is

(2) If there are no underlying diagnostic horizons and the organic-carbon content of the underlying materials decreases irregularly with increasing depth (as in recent alluvium that is not finely stratified); *or*

e. In other soils, the epipedon must be 18 cm (7 in.) or more thick if none of the conditions that are listed in *b*, *c*, and *d* exist.

6. The epipedon has less than 250 parts per million (ppm) of P_2O_5 soluble in 1 percent citric acid, or it either has increasing amounts of P_2O_5 soluble in citric acid below the epipedon or the amounts of P_2O_5 soluble in citric acid decrease or increase irregularly with depth below the epipedon, or there are phosphate nodules within the epipedon. This restriction is made to eliminate plow layers of very old arable soils and kitchen middens that have acquired, under use, the properties of the mollic epipedon, but to include the epipedon of a soil developed in highly phosphatic parent material.

7. If the soil is not irrigated, some part of the epipedon is moist 3 months or more of the year (cumulative) in more than 7 out of 10 years at times when the soil temperature at a depth of 50 cm is 5°C or higher.

8. The *n* value (defined later in this chapter) is less than 0.7. Although many soils that have a mollic epipedon are very poorly drained, a mollic epipedon does not have the very high water content of sediments that have been continuously under water since deposition.

Ochric epipedon (Gr. *ochros*, pale)

An ochric epipedon is one that is too high in value or chroma, is too dry, has too little organic matter, has an *n* value too high, or is too thin to be mollic, umbric, anthropic, plaggen or histic, or it is both hard and massive when dry. An epipedon is ochric if the Munsell color value after rubbing is 6 or higher when dry or 4 or higher when moist, if the chroma is 4 or more[2], or if the A or Ap horizon that has both low value and low chroma is too thin to be a mollic or an umbric epipedon. Epipedons that have a color value after rubbing of 5 or less, dry, and 3 or less, moist, are also ochric provided they are no darker than the 1C horizon and do not have as much as 0.6 percent more organic carbon than the 1C horizon. The ochric epipedon includes eluvial horizons that are at or near the surface (the E horizon and an albic horizon, which is defined later) and extends to the first underlying diagnostic illuvial horizon (defined later as an argillic,

---

[2] The chroma is permitted to range up to but not to include 4.0 soils that have a hyperthermic or isohyperthermic temperature regime. The color when moist is that of a specimen that is moist enough that an additional drop of water produces no change in the color. The color when dry is that of a specimen dry enough that continued drying produces no further change.

1. Texture that is very fine sand, loamy very fine sand, or finer in the fine-earth (less than 2.0 mm) fraction; *and*

2. Soil structure or absence of rock structure in at least half the volume; *and*

3. Minerals that consist of (a) enough amorphous or 2:1 lattice clay to give a cation-exchange capacity (by NH_4OAc) of more than 16 cmol(+) per kg clay or (b) 10 percent or more weatherable minerals; *and*

4. Evidence of alteration in one of the following forms:

a. Have an aquic moisture regime or artificial drainage and, beginning at a depth of less than 50 cm, colors with a hue no bluer than 10Y if the hue changes on exposure to air, and dominant chroma on faces of peds if peds are present or in the matrix if peds are absent as follows:

(1) If there is mottling, the chroma is 2 or less; *or*

(2) If there is no mottling and the value is less than 4, the chroma is less than 1; if the value is 4 or more, the chroma is 1 or less; *and*

(3) One or more of the following properties:

(a) A regular decrease in the amount of organic carbon with depth and a content of less than 0.2 percent organic carbon at a depth of 125 cm below the surface or immediately above a sandy-skeletal substratum that is at a depth of less than 125 cm; *or*

(b) Cracks that open and close in most years and are 1 cm or more wide at a depth 50 cm below the surface; *or*

(c) Permafrost at some depth; *or*

(d) A histic epipedon consisting of mineral soil materials or a mollic or umbric epipedon; *or*

b. Do not have an aquic moisture regime or artificial drainage and colors as defined in "a." and have one or more of the following properties:

(1) Stronger chroma, redder hue, or higher clay content than the underlying horizon; *or*

(2) Evidences of removal of carbonates. Particularly, the cambic horizon has less carbonate than the underlying k horizon. If all coarse fragments in the k horizon are completely coated with lime, some in the cambic horizon are partly free of coatings. If coarse fragments in the k horizon are

coated only on the under side, those in the cambic horizon should be free of coatings; *or*

(3) If carbonates are absent in the parent material and in the dust that falls on the soil, the required evidence of alteration is satisfied by the presence of soil structure and the absence of rock structure; *and*

5. Properties that do not meet the requirements of an argillic, kandic, or spodic horizon; *and*

6. No cementation or induration and no brittle consistence when moist; *and*

7. Enough thickness that its base is at least 25 cm (10 in.) below the soil surface unless the soil temperature regime is cryic or pergelic.

Duripan

The duripan (L. *durus*, hard, plus pan; meaning hardpan) is a subsurface horizon that is cemented by silica to the degree that fragments from the air-dry horizon do not slake during prolonged soaking in water or in HCl. In summary, the duripan is a silica-cemented subsurface horizon in which

1. Cementation is strong enough that dry fragments from some subhorizon do not slake in water, even during prolonged wetting; *and*

2. Coatings of silica, insoluble in 1N HCl even during prolonged soaking but soluble in hot concentrated KOH or in alternating acid and alkali, are present in some pores and on some structural faces; or some durinodes are present; *and*

3. Cementation is not destroyed by soaking in acid in more than half of any laminar capping that may be present or in some other continuous or imbricated subhorizon. Cementation in such layers is completely destroyed by hot concentrated KOH, either by a single treatment or by alternating with acid; *and*

4. If fractured, the average lateral distance between fracture points is 10 cm or more.

Fragipan

A fragipan (modified from L. *fragilis*, brittle, and pan; meaning brittle pan) is a loamy or uncommonly a sandy subsurface horizon that may but does not necessarily underlie a cambic, spodic, argillic, or albic horizon. It has a very low content of organic matter, has high bulk density relative to the horizons above it, and is seemingly cemented when dry, having then hard or very hard consistence. When moist, a fragipan has moderate or

Sixth, texture of the fine-earth fraction of a fragipan is finer than fine sand, and the percentage of clay is generally less than 35; in most soils appreciably less. The texture normally is loamy, that is, silt loam, loam, or sandy loam.

Seventh, an air-dry fragment about the size of a fist slakes or fractures when placed in water.

Gypsic horizon

The gypsic horizon is a noncemented or weakly cemented horizon of enrichment with secondary sulfates that is 15 cm or more thick, has at least 5 percent more gypsum than the C horizon or the underlying stratum, and in which the product of the thickness in centimeters and the percentage of gypsum is 150 or more. Thus, a horizon 30 cm thick that has 5 percent gypsum qualifies if gypsum is absent in the underlying horizon. A layer 30 cm thick that has 6 percent gypsum qualifies if the gypsum content of the underlying horizon is not more than 1 percent. Cementation is weak enough that a dry fragment slakes in water.

The percentage of gypsum can be calculated by multiplying the milliequivalents of gypsum per 100 g soil by the milliequivalent weight of gypsum, which is 0.086.

Kandic horizon[4]

The kandic horizon:

1. Is a vertically continuous subsurface horizon and has, starting at the point where the clay increase requirements are met, a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in at least the major part of the horizon.

2. Has a thickness of at least 30 cm, or if a lithic, paralithic, or petroferric contact occurs within 50 cm of the soil surface, then the thickness of the kandic horizon is at least 60 percent of the vertical distance between 18 cm and the contact but at least 15 cm thick.

3. Has a texture of loamy very fine sand or finer.

4. Underlies a coarser textured surface horizon. The minimum thickness of the surface horizon is 18 cm after mixing, or 5 cm if the textural transition to the kandic horizon is abrupt and if there is no lithic, paralithic, or petroferric contact within 50 cm.

---

[4] The kandic horizon, and the *kandi* and *kanhapli* great groups in following chapters, represent the work of the International Committee on the Classification of Low Activity Clays (ICOMLAC), chaired by F.R. Moormann.

extremely hard when dry, and very firm or extremely firm when moist. Noncapillary pores are filled, and the petrocalcic horizon is a barrier to roots. Hydraulic conductivity is moderately slow to very slow. The horizon is usually much more than 10 cm (4 in.) thick.

A laminar capping commonly is present but is not required.

If a laminar horizon rests on bedrock, it is considered a petrocalcic horizon if it is 2.5 cm or more thick and the product of the thickness in centimeters multiplied by the percentage of $CaCO_3$ equivalent is 200 or more.

Petrogypsic horizon

The petrogypsic horizon is a gypsic horizon that is strongly enough cemented with gypsum that dry fragments do not slake in water and that roots cannot enter. The gypsum content commonly is far greater than the minimum requirements for the gypsic horizon and usually exceeds 60 percent. Petrogypsic horizons are restricted to arid climates and to parent materials that are rich in gypsum.

Placic horizon

The placic horizon (Gr. base of *plax*, flat stone; meaning a thin cemented pan) is a thin, black to dark reddish pan cemented by iron, by iron and manganese, or by an iron-organic matter complex. Its thickness ranges generally from 2 to 10 mm. Rarely, it is as thin as 1 mm or as thick as 20 to 40 mm in spots. It may be, but is not necessarily, associated with stratification in parent materials. It is in the solum, roughly parallel to the soil surface, and is commonly within the upper 50 cm of the mineral soil. It has a pronounced wavy or even convolute form. It normally occurs as a single pan, not as multiple sheets one underlying another, but in places it may be bifurcated. It is a barrier to water and roots.

An iron-cemented pan is strong brown to dark reddish brown. A pan cemented by iron and manganese or by iron-organic matter complexes is black or reddish black. A single pan may contain two or more layers cemented by different agents. Iron-organic matter cements commonly are present in the upper part of the pan.

Identification is seldom difficult. The hard brittle pan differs so much from the material in which it occurs and is so close to the surface of the mineral soil material that it is obvious unless its thickness is minimal. A few analyses of placic horizons show that organic carbon is present in amounts ranging from 1 percent to 10 percent or more. The presence of organic carbon as well as the shape and position of the pan distinguish the placic horizon from the ironstone sheet that may form where

materials. Such a horizon is highly toxic to plants and virtually free of living roots.

OTHER DIAGNOSTIC SOIL CHARACTERISTICS

Abrupt textural change

An abrupt textural change is a change from an ochric epipedon or an albic horizon to an argillic horizon. There is, in the zone of contact, a very appreciable increase in clay content within a very short distance in depth. If the clay content of the ochric epipedon or the albic horizon is less than 20 percent, the clay content should double within a distance in depth of 7.5 cm or less. If the clay content exceeds 20 percent, the increase in clay content should be at least 20 percent of the fine-earth fraction, for example, from 22 percent to 42 percent, within a distance of 7.5 cm in depth, and the clay content in some part of the argillic horizon should be at least double that of the horizon above. A transitional horizon normally is not present or is too thin to be sampled. In some soils, however, there may be tonguing or interfingering of albic materials, which are defined later, in parts of the argillic horizon. The horizon boundary in such a soil is irregular or even discontinuous. The sampling of such a mixture as a single horizon might create the impression of a relatively thick transitional horizon, even though the thickness of the actual transition at the contact may be only 1 mm or so.

Andic soil properties

To have andic soil properties, the soil material must have less than 25 percent organic carbon and meet one or both of the following two requirements:

1. *Either*

   a. Acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron is 2.0 percent or more in the less than 2.0 mm fraction, *and*

   b. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, is 0.90 g cm^{-3} or less, *and*

   c. Phosphate retention[7] of the less than 2.0 mm fraction is 85 percent or more; *or*

2. The less than 2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02 - 2.0 mm fraction is at least 30 percent of the less than 2.0 mm fraction; and meets one of the following three requirements:

---

[7] Blakemore, L.C.; Searle, P.L.; Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. p. 44-45.

a. The less than 2.0 mm fraction has acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more, and there is at least 30 percent volcanic glass in the 0.02 - 2.0 mm fraction, *or*

b. The less than 2.0 mm fraction has acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 2.0 percent or more, and there is at least 5 percent volcanic glass in the 0.02 - 2.0 mm fraction, *or*

c. The less than 2.0 mm fraction has acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of between 0.40 percent and 2.0 percent, and there is enough volcanic glass in the 0.02 - 2.0 mm fraction that the percentage of glass, when plotted against the percentage of acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron, gives a point within the shaded area of Figure 1.

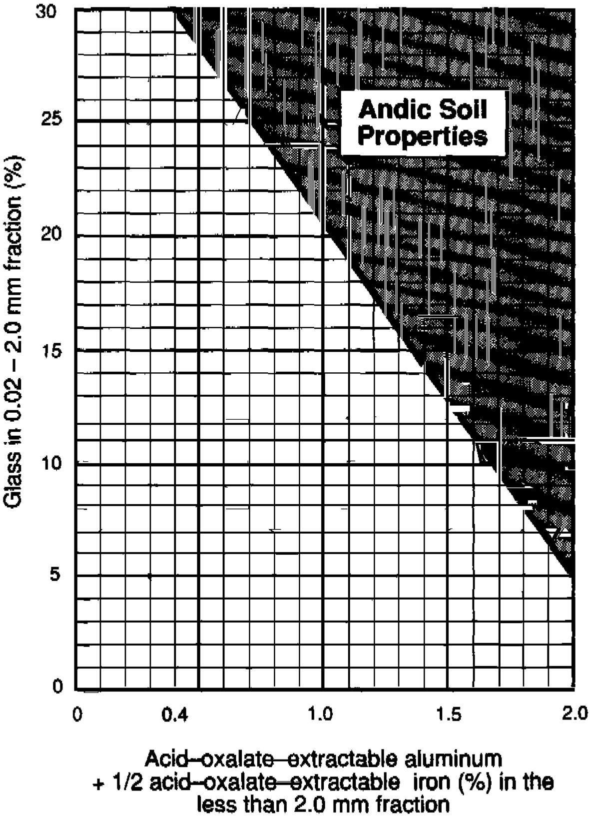

Figure 1 — *Soils that plot in the shaded area have Andic soil properties if the less than 2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02 to 2.0 mm fraction is at least 30 percent of the less than 2.0 mm fraction.*

diagnostic soil horizons such as a duripan or a petrocalcic horizon.

A lithic contact is diagnostic at the subgroup level if it is within 125 cm of the soil surface of Oxisols and within 50 cm of the soil surface of all other mineral soils.

Mottles that have chroma of 2 or less

It refers to colors in a horizon in which parts have chroma of 2 or less, moist, and value, moist, of 4 or more, whether or not that part is dominant in volume or whether or not it is a continuous phase surrounding spots of higher chroma. If either the minor or major part of a horizon has chroma of 1 to 2 and value, moist, of 4 or more and there are spots of higher chroma, the part that has the lower chroma is included in the meaning of "mottles that have chroma of 2 or less." The part is excluded from the meaning if all the horizon has chroma of 2 or less or if no part of the horizon has chroma as low as 2.

The phrase also means that the horizon that has such mottles is saturated with water at some period of the year or the soil is artificially drained. It is also implicit in the meaning that the temperature of the horizon is above the biologic zero, which is about 5°C (41°F), during at least a part of the time that the horizon is saturated.

***n* value**

The *n* value (Pons and Zonneveld 1965) refers to the relation between the percentage of water under field conditions and the percentages of inorganic clay and of humus. The *n* value is helpful in predicting whether the soil may be grazed by livestock or will support other loads, and the degree of subsidence that would occur after drainage. The *n* value can be calculated for mineral soil materials that are not thixotropic by the formula:

$$n = (A - 0.2R)/(L + 3H)$$

A is the percentage of water in the soil in field condition, calculated on a dry-soil basis; *R* is the percentage of silt plus sand; *L* is the percentage of clay; and *H* is the percentage of organic matter (organic carbon x 1.724).

Few data are available in the United States for calculations of the *n* value, but the critical *n* value of 0.7 can be approximated closely in the field by a simple test of squeezing the soil in the hand. If the soil flows with difficulty between the fingers, the *n* value is between 0.7 and 1.0. If the soil flows easily between the fingers, the *n* value is 1 or more.

Soft powdery lime

Soft powdery lime is a phrase that is used in the definitions of a number of taxa. It refers to translocated authigenic lime, soft enough to be cut readily with a fingernail, that was precipitated in place from the soil solution rather than inherited from a soil parent material such as a calcareous loess or till. It should be present in a significant enough accumulation to constitute a k horizon.

To be identifiable, soft powdery lime must have some relation to the soil structure or fabric. It may disrupt the fabric to form spheroidal aggregates, or white eyes, that are soft and powdery when dry. Or the lime may be present as soft coatings in pores or on structural faces. If present as coatings, it covers a significant part of the surface. Commonly, it coats the whole surface to a thickness of 1 to 5 mm or more. But only part of a surface may be coated if little lime is present in the soil. The coatings should be thick enough to be visible when moist and should cover a continuous area large enough to be more than filaments. The pseudomycelia commonly seen in a dry calcareous horizon do not come within the meaning of soft powdery lime. Pseudomycelia are soft powdery filaments on structural faces, commonly branching, but they may come and go with the seasons and may be only lime that was precipitated in a single season by the withdrawal of stored soil moisture rather than a k horizon.

Soft coatings on hard lime concretions are also excluded from the meaning of soft powdery lime. These may be thin or thick, and they may be the result of either current accumulation or removal of lime. That is, the concretion may be growing or may be undergoing dissolution, and either process can produce a soft coating.

Soil moisture regimes

The soil moisture regime, as the term is used here, refers to the presence or absence either of ground water or of water held at a tension less than 1500 kPa in the soil or in specific horizons by periods of the year. Water held at a tension of 1500 kPa or more is not available to keep most mesophytic plants alive. The availability of water also is affected by dissolved salts. A soil may be saturated with water that is too salty to be available to most plants, but it would seem better to call such a soil salty rather than dry. Consequently, we consider a horizon to be dry when the moisture tension is 1500 kPa or more. If water is held at a tension of less than 1500 kPa but more than zero, we consider the horizon to be moist. A soil may be continuously moist in some or all horizons throughout the year or for some part of the year. It may be moist in winter and dry in summer or the reverse. In the northern hemisphere, summer refers to the months of June, July, and August, and winter means December, January, and February. A soil or a horizon is considered to be saturated with water when water stands in an unlined borehole close enough to the soil surface or to the horizon in question that the capillary fringe[8] reaches the surface or the top of the horizon.

Soil moisture control section

The intent in defining the soil moisture control section is to facilitate estimation of soil moisture regimes from climatic data. The upper boundary of this control section is the depth to which a dry (tension of more than 1500 kPa but not air dry) soil will be moistened by 2.5 cm (1 in.) of water within 24 hours. The lower boundary is the depth to which a dry soil will be moistened by 7.5 cm (3 in.) of water within 48 hours. These depths are exclusive of the depth of moistening along any cracks or animal burrows that are open to the surface.

If 7.5 cm of water moistens the soil to a lithic, petroferric, or paralithic contact or to a petrocalcic horizon or a duripan, the upper boundary of the rock or of the cemented horizon is the lower boundary of the soil moisture control section. If 2.5 cm of water moistens the soil to one of these contacts or horizons, the soil moisture control section is the lithic contact itself, the paralithic contact, or the upper boundary of the cemented horizon. The control section of the latter soil is moist if the upper boundary of the rock or the cemented horizon has a thin film of water. If the upper boundary is dry, the control section is dry.

As a rough guide to the limits, the soil moisture control section lies approximately between 10 and 30 cm (4 and 12 in.) if the particle-size class is fine-loamy, coarse-silty, fine-silty, or clayey. The control section extends approximately from a depth of 20 cm to a depth of 60 cm (8 to 24 in.) if the particle-size class is coarse-loamy, and from 30 to 90 cm (12 to 35 in.) if the particle-size class is sandy.

Classes of soil moisture regimes

The moisture regimes are defined in terms of the ground-water level and in terms of the presence or absence of water held at a tension less than 1500 kPa in the moisture control section by periods of the year. It is assumed in the definitions that the soil supports whatever vegetation it is capable of supporting. In other words, it is in crops, grass, or native vegetation; it is not being fallowed to increase the amount of stored moisture, nor is it being irrigated by man. These cultural practices affect the soil moisture condition as long as they are continued.

---

[8] The capillary fringe is the zone just above the water table (zero gauge pressure) that remains almost saturated (Soil Sci. Soc. Amer. Glossary, 1965, p. 332).

Aquic moisture regime.--The aquic (L. *aqua*, water) moisture regime implies a reducing regime that is virtually free of dissolved oxygen because the soil is saturated by ground water or by water of the capillary fringe. An aquic regime must be a reducing one. Some soil horizons, at times, are saturated with water while dissolved oxygen is present, either because the water is moving or because the environment is unfavorable for micro-organisms; for example, if the temperature is less than $1^{\circ}C$ such a regime is not considered aquic.

For differentiation in the highest categories of soils that have an aquic regime, the whole soil must be saturated. In the subgroups, only the lower horizons are saturated. The soil is considered to be saturated if water stands in an unlined borehole at such a shallow depth that the capillary fringe (see footnote 8) reaches the soil surface except in noncapillary pores. The water in the borehole is stagnant and remains colored if a dye is placed in the water. In a sandy soil, the thickness of the capillary fringe may be only 10 to 15 cm. In a loamy or clayey soil that does not shrink or swell appreciably, the thickness may be 30 cm or more, depending on the size distribution of the pores.

The duration of the period that the soil must be saturated to have an aquic regime is not known. The duration must be at least a few days, because it is implicit in the concept that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of micro-organisms, roots and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero ($5^{\circ}C$) at some time while the soil or the horizon is saturated.

Very commonly, the level of ground water fluctuates with the seasons. The level is highest in the rainy season, or in fall, winter, or spring if cold weather virtually stops evapotranspiration. There are soils, however, in which the ground water is always at or very close to the surface. A tidal marsh and a closed, landlocked depression fed by perennial streams are examples. The moisture regime in these soils is called "peraquic." Although the term is not used as a formative element for names of taxa, it is used in their descriptions as an aid in understanding genesis.

Aridic and torric (L. *aridus*, dry, and L. *torridus*,[9] hot and dry) moisture regimes.--These terms are used for the same moisture regime but in different categories of the taxonomy.

In the aridic (torric) moisture regime, the moisture control section in most years is

---

[9] *Torridus* is not the ideal root, but a better one could not be found. Although soils may not be hot throughout the year, soils that have a torric moisture regime are hot and dry in summer.

Ustic moisture regime.--The ustic (L. *ustus*, burnt, implying dryness) moisture regime is intermediate between the aridic and the udic regime. The concept is one of limited moisture, but the moisture is present at a time when conditions are suitable for plant growth. The ustic moisture regime is not applied to soils that have cryic or pergelic temperature regimes, which are defined later.

If the mean annual soil temperature is 22°C or higher or if the mean summer and winter soil temperatures differ by less than 5°C at a depth of 50 cm, the soil moisture control section in the ustic moisture regime is dry in some or all parts for 90 or more cumulative days in most years. But the moisture control section is moist in some part for more than 180 cumulative days, or it is continuously moist in some part for at least 90 consecutive days.

If the mean annual soil temperature is lower than 22°C and if the mean summer and winter soil temperatures differ by 5°C or more at a depth of 50 cm, the soil moisture control section in the ustic regime is dry in some or all parts for 90 or more cumulative days in most years. But it is not dry in all parts for more than half the time that the soil temperature is higher than 5°C at a depth of 50 cm (the aridic and torric regimes). Also, it is not dry in all parts for as long as 45 consecutive days in the 4 months that follow the summer solstice in 6 or more years out of 10 if the moisture control section is moist in all parts for 45 or more consecutive days in the 4 months that follow the winter solstice in 6 or more years out of 10 (xeric regime).

In tropical and subtropical regions that have either one or two dry seasons, summer and winter have little meaning. In those regions, the ustic regime is that typified in a monsoon climate that has at least one rainy season of 3 months or more. In temperate regions of subhumid or semiarid climates, the rainy seasons are usually spring and summer or spring and fall, but never winter. Native plants are mostly annuals or they have a dormant period while the soil is dry.

Xeric moisture regime.--The xeric moisture regime (Gr. *xeros*, dry) is that typified in Mediterranean climates, where winters are moist and cool and summers are warm and dry. The moisture, coming in winter when potential evapotranspiration is at a minimum, is particularly effective for leaching. In a xeric moisture regime, the soil moisture control section is dry in all parts for 45 or more consecutive days within the 4 months that follow the summer solstice in 6 or more years out of 10. It is moist in all parts for 45 or more consecutive days within the 4 months that follow the winter solstice in 6 or more years out of 10. The moisture control section is moist in some part more than half the time, cumulative, that the soil temperature at a depth of 50 cm is higher than 5°C, or in 6 or more years out of 10 it is moist in some part for at least

90 consecutive days when the soil temperature at a depth of 50 cm is continuously higher than 8°C. In addition, the mean annual soil temperature is lower than 22°C, and mean summer and mean winter soil temperatures differ by 5°C or more at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Soil temperature regimes

Classes of soil temperature regimes

The following soil temperature regimes are used in defining classes at various categoric levels in the taxonomy.

Pergelic (L. *per*, throughout in time and space, and L. *gelare*, to freeze; connoting permanent frost).--Soils with a pergelic temperature regime have a mean annual temperature lower than 0°C. These are soils that have permafrost if they are moist, or dry frost if excess water is not present. It seems likely that the moist and the dry pergelic regimes should be defined separately, but at present we have only fragmentary data on the dry soils of very high latitudes.

Cryic (Gr. *kryos*, coldness; connoting very cold soils).--In this regime soils have a mean annual temperature higher than 0°C (32°F) but lower than 8°C (47°F).

1. In mineral soils the mean summer soil temperature (June, July, and August in the northern hemisphere and December, January, and February in the southern hemisphere) at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, is as follows:

   a. If the soil is not saturated with water during some part of the summer, *and*

      (1) There is no O horizon, lower than 15°C (59°F); *or*

      (2) There is an O horizon, lower than 8°C (47°F);

   b. If the soil is saturated with water during some part of the summer, *and*

      (1) There is no O horizon, lower than 13°C (55°F); *or*

      (2) There is an O horizon or a histic epipedon, lower than 6°C (43°F).

2. In organic soils, *either*

   a. The soil is frozen in some layer within the control section in most years about 2 months after the summer solstice; that is, the soil is very cold in winter but warms up slightly in summer; *or*

Isohyperthermic.--The mean annual soil temperature is 22°C or higher.

Sulfidic materials

Sulfidic materials are waterlogged mineral or organic soil materials that contain 0.75 percent or more sulfur (dry weight), mostly in the form of sulfides, and that have less than three times as much carbonate ($CaCO_3$ equivalent) as sulfur. Sulfidic materials accumulate in a soil that is permanently saturated, generally with brackish water. The sulfates in the water are biologically reduced to sulfides as the soil materials accumulate. Sulfidic materials are most common in coastal marshes near the mouths of rivers that carry noncalcareous sediments, but they may occur in fresh-water marshes if there is sulfur in the water. If the soil is drained, the sulfides oxidize and form sulfuric acid. The pH, which normally is near neutrality before drainage, may drop below 2. The acid reacts with the soil to form iron and aluminum sulfates. The iron sulfate, jarosite, segregates and forms the bright-yellow mottles that characterize a sulfuric horizon. The transition from sulfidic materials to a sulfuric horizon normally requires a very few years. A sample of sulfidic materials, if air dried slowly in shade for about 2 months with occasional remoistening, becomes extremely acid. For quick identification in the field, a sample can be oxidized by boiling in concentrated H_2O_2 and measuring the drop in pH.[10]

Tonguing and interfingering

Tonguing of albic materials

Tongues of albic materials consist of penetrations of bleached material that has the color of an albic horizon in an argillic or a natric horizon, along ped surfaces if peds are present. No continuous albic horizon need be present above the tongues. The penetrations have a vertical dimension of more than 5 cm in any argillic or natric horizon. Their horizontal dimension is 5 mm or more in a fine-textured argillic or natric horizon (clay, silty clay, or sandy clay), 10 mm or more in a moderately fine textured argillic or natric horizon (clay loam, sandy clay loam, or silty clay loam), and 15 mm or more in a medium or coarser textured argillic or natric horizon (silt loam, loam, very fine sandy loam, or coarser). The penetrations must occupy more than 15 percent of the matrix of some part of the argillic or natric horizon before they are considered tongues.

---

[10] Concentrated H_2O_2 can cause serious burns and is dangerous. Gloves should be worn, and precautions should be taken against spilling, leakage, or spattering.

It should be noted that this is a restricted meaning of weatherable minerals. Calcite, for example, is readily soluble in a humid environment. If it is dissolved, it leaves no trace or residue. Soils that have been intensely and deeply weathered in a humid environment of the past are, in some places, preserved today in an arid environment. Calcite could reappear in one of these soils if it were brought in as dust. The intent is to include, in the context of the meaning of weatherable minerals for this purpose, only those minerals that are unstable in a humid climate relative to other minerals, such as quartz and 1:1 lattice clays, and that are more resistant to weathering than calcite.

LITERATURE CITED

Brewer, R. 1964. Fabric and mineral analysis of soil. John Wiley and Sons, Inc., New York, London, Sydney. 470 p.

Pons, L.J. and I.S. Zonneveld. 1965. Soil ripening and soil classification. Initial soil formation in alluvial deposits and a classification of the resulting soils. Int. Inst. Land Reclam. and Impr. Pub. 13. Wageningen, The Netherlands. 128 p.

1. The fiber content after rubbing is three-fourths[1] or more of the soil volume, excluding coarse fragments and mineral layers; *or*

2. The fiber content after rubbing is two-fifths or more of the soil volume, excluding coarse fragments and mineral layers, and the material yields a sodium pyrophosphate extract color on white chromatographic paper that has value and chroma of 7/1, 7/2, 8/1, 8/2, or 8/3 (Munsell designations).

Hemic soil materials

Hemic soil materials (Gr. *hemi*, half; implying intermediate decomposition) are intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric materials. They have morphological features that give intermediate values for fiber content, bulk density, and water content. They are partly altered both physically and biochemically.

Sapric soil materials (Gr. *sapros*, rotten)

These are the most highly decomposed of the organic materials. They normally have the smallest amount of plant fiber, the highest bulk density, and the lowest water content on a dry-weight basis at saturation. They are commonly very dark gray to black. They are relatively stable, i.e., they change very little physically and chemically with time in comparison to the others.

Sapric materials have the following characteristics:

1. The fiber content after rubbing is less than one-sixth of the soil volume, excluding coarse fragments and mineral layers; *and*

2. The sodium pyrophosphate extract color on chromatographic paper is below or to the right of a line drawn to exclude blocks 5/1, 6/2, and 7/3.

Humilluvic materials

Illuvial humus accumulates in the lower parts of some organic soils if they are acid and have been drained and cultivated. The illuvial humus has a younger C^{14} age than the overlying organic materials. It has very high solubility in sodium pyrophosphate and rewets very slowly after drying. Most commonly it accumulates near a contact with a sandy mineral horizon. To be recognized as a differentia in classification, the illuvial humus should constitute at least half the volume of a layer at least 2 cm thick.

---

[1] Fractions are used rather than percentages to avoid implying a higher degree of accuracy than is warranted.

1. Has a color value, moist, of 5 or more; *and*

2. Reacts with dilute HCl to evolve CO_2.

Marl usually does not change color irreversibly on drying. A layer of marl contains too little organic matter to coat the carbonate, even before it has been shrunk by drying.

THICKNESS OF ORGANIC MATERIALS (CONTROL SECTION)

For practical reasons an arbitrary control section has been established for taxonomy of Histosols. It is either 130 cm (51 in.) or 160 cm (63 in.) thick, depending on the kind of material, provided that no lithic or paralithic contact, thick layer of water, or frozen soil occurs within those limits. The thicker control section is used if the surface layer to a depth of 60 cm (24 in.) has three-fourths or more fibers derived from *Sphagnum* or from *Hypnum* or other mosses or has a bulk density less than 0.1. Layers of water may be thin or thick, from a few centimeters to many meters. Water is taken as the base of the control section only if the water extends below a depth of 130 cm or 160 cm, depending on the kind of material above it. A lithic or a paralithic contact shallower than 130 cm (51 in.) or 160 cm (63 in.), depending on the kind of material above it, is taken as the base of the control section, or the base is placed 25 cm (10 in.) below the depth at which the soil is frozen about 2 months after the summer solstice. An unconsolidated mineral substratum shallower than those limits does not change the base of the control section.

The control section has been divided somewhat arbitrarily into three tiers, the surface, subsurface, and bottom tiers.

Surface tier

The surface tier is the upper 60 cm (24 in.) if (1) the material is fibric and three-fourths or more of the fiber volume is derived from *Sphagnum* or mosses, or (2) the material has a bulk density less than 0.1; otherwise, the surface tier is the top 30 cm (12 in.) exclusive of loose surface litter or living mosses.

A surface mineral layer less than 40 cm (16 in.) thick is present on some organic soils as a result of flooding, additions by men to increase soil strength or reduce frost hazard, volcanic eruptions, or other causes. If present, it is considered a part of the surface tier, even though it may be more than 30 cm thick, and the depth then is measured from the top of the mineral layer.

Chapter 3

Family Differentiae

MINERAL SOILS

The differentiae used to distinguish families of mineral soils within a subgroup are listed next in the order in which the descriptive terms appear in the family name and in which the terms are defined in this chapter.

- Particle-size classes
- Mineralogy classes
- Calcareous and reaction classes
- Soil temperature classes
- Soil depth classes
- Soil slopes classes
- Soil consistence classes
- Classes of coatings (on sand)
- Classes of cracks

Particle-size classes

Particle size refers to grain-size distribution of the whole soil and is not the same as texture, which refers to the fine-earth fraction. The fine-earth fraction consists of the particles that have a diameter of less than 2.0 mm. Particle-size classes are a kind of compromise between engineering and pedologic classifications. The limit between sand and silt is a diameter of 74 microns in the engineering classification and of either 50 or 20 microns in pedologic classifications. The engineering classifications are based on percentages by weight in the fraction less than 74 mm in diameter, and textural classes are based on percentages by weight in the fraction less than 2.0 mm in diameter.

The very fine sand separate (diameter between 0.05 mm and 0.1 mm) is split in engineering classifications. In defining particle-size classes, much the same split is made but in a different manner. A fine sand or loamy fine sand normally has an appreciable content of very fine sand, but the very fine sand fraction is mostly coarser than 74 microns. A silty sediment, such as loess, may also have an appreciable component of very fine sand, but most of the very fine sand is finer than 74 microns. So, in particle-size classes, the very fine sand is allowed to "float." It is treated as sand if the texture is fine sand, loamy fine sand, or a coarser class. It is treated as silt if the texture is very fine sand, loamy very fine sand, sandy loam, silt loam, or a finer class.

No single set of particle-size classes seems appropriate as family differentiae for all kinds of soils. The classes that follow provide for a choice of either 7 or 11 particle-size classes. This choice permits relatively fine

Fine-loamy. By weight, 15 percent or more of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; 18 through 34 percent clay in the fine-earth fraction (less than 30 percent in Vertisols).

Coarse-silty. By weight, less than 15 percent of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; less than 18 percent clay in the fine-earth fraction.

Fine-silty. By weight, less than 15 percent of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; 18 through 34 percent clay in the fine-earth fraction (less than 30 percent in Vertisols).

Clayey.[2]-- The fine earth contains 35 percent or more clay by weight, and rock fragments are less than 35 percent by volume.

Fine. A clayey particle-size class that has 35 through 59 percent clay in the fine-earth fraction (30 through 59 percent in Vertisols).

Very-fine. A clayey particle-size class that has 60 percent or more clay in the fine-earth fraction.

<u>Modifiers that replace names of particle-size classes</u>[3]

There are three situations in which particle-size class names are not used. In one, the name is redundant. Psamments and Psammaquents, by definition, are sandy, and no particle-size class name is needed or used in the family name.

In the second situation, soil materials derived from volcanic ejecta, particle-size analysis is difficult to apply because the soil material commonly consists of aggregates containing volcanic glass and allophane.

---

[2] If the ratio of 1500 kPa water retention to clay is 0.6 or more in half or more of the control section, the percentage of clay is considered to be 2.5 times the percentege of 1500 kPa water retention. Carbonates of clay size are not considered to be clay but are treated as silt in all particle-size classes.

[3] The definition of the geologic terms used in the substitute particle-size classes are the same as those in: Bates, R.L.; Jackson, J.A. (Eds.). 1980. Glossary of Geology (Second Edition). American Geological Institute. Falls Church, VA. 751 p., with the following exceptions:

<u>Cinders</u>: Uncemented juvenile vitric vesicular pyroclastic material, more than 2.0 mm in at least one dimension, with an apparent specific gravity (including vesicles) of more than 1.0 and less than 2.0.

<u>Lapilli</u>: Non- or slightly vesicular pyroclastics, 2.0 to 76 mm in at least one dimension, with an apparent specific gravity of 2.0 or more.

<u>Pumice-like</u>: Vesicular pyroclastic materials other than pumice but having an apparent specific gravity (including vesicles) of less than 1.0.

These components are not adequately described by normal particle-size classes, especially as they often cannot be readily dispersed and the results of dispersion are variable. Consequently, normal particle-size class names are not used for that part of the soil that has andic soil properties or that is high in volcanic glass, as is the situation with Andisols by definition. In families of Andisols and in most andic and vitrandic subgroups of other soil orders the following substitutes for particle-size class names are used for the part of the soil that does not disperse.

In the third situation, the content of allophane and organic matter is also high and particle size has only limited relation to the physical and chemical properties of the soils. This seems to be normal in soils that have both a cryic temperature regime and a spodic horizon. Therefore, particle-size class names are not used for the spodic horizons of most Cryaquods, Cryohumods, Cryorthods, or Cryic Placohumods and for some other Spodosols[4].

The following terms are substituted for the particle-size class names in the taxa that have been listed unless the particle-size modifier is redundant. They reflect a combination of particle size and mineralogy, and they take the place of both.

A. Substitutes for the fragmental class:

These classes have insufficient fine earth to fill 10 percent of interstices coarser than 1 mm.

Pumiceous - More than 60 percent by weight of the whole soil is composed of volcanic ash, cinders, lapilli, pumice and pumice-like[5] fragments more than 1 mm in diameter; pumice or pumice-like fragments form two-thirds or more by volume of the fraction coarser than 2.0 mm.

Cindery - More than 60 percent by weight of the whole soil is composed of volcanic ash, cinders, lapilli, pumice and pumice-like fragments more than 1 mm in diameter; pumice or pumice-like fragments form less than two-thirds by volume of the fraction coarser than 2.0 mm.

B. Substitutes for the non-fragmental classes:

---

[4] Particle-size class names are applied to other spodic horizons but with reservations. Somewhat different classes probably should be used for most families of Spodosols, but data are too few to permit the testing of alternatives. Some series that would otherwise be reasonably homogeneous are split at the family level by the particle-size classes. These soils have appreciable but not very large amounts of organic matter in the spodic horizon.

[5] Pumice-like: Vesicular pyroclastic materials other than pumice but having an apparent specific gravity (including vesicles) of less than 1.0 g/cc.

These classes have sufficient fine earth to fill 10 percent or more of the interstices coarser than 1 mm.

Ashy - Rock fragments make up less than 35 percent by volume and the fine earth is *either*:

a. Thirty percent or more by weight volcanic glass, glass aggregates, glass coated grains or other vitric volcaniclastics; *or*

b. Thirty percent or more by weight is between 0.02 and 2.0 mm in diameter and 5 percent or more of the 0.02 to 2.0 mm fraction is volcanic glass, glass aggregates, glass coated grains, or other vitric volcaniclastics, and the $Al_o + Fe_o/2$ is 0.4 percent or more, and the water at 1500 kPa is less than 30 percent on undried samples and less than 12 percent on dried samples of the fine earth.

Ashy-pumiceous - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are two-thirds or more by volume of the rock fragments; fine earth is ashy.

Ashy-skeletal - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are less than two-thirds by volume of the rock fragments; fine earth is ashy.

Medial - The fine earth has andic soil properties; water at 1500 kPa is 12 percent or more on air-dried samples of the fine earth, or is 30 percent or more on undried samples, but is less than 100 percent on undried samples; rock fragments make up less than 35 percent by volume.

Medial-pumiceous - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are two-thirds or more by volume of the rock fragments; fine earth is medial.

Medial-skeletal- Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are less than two-thirds by volume of the rock fragments; fine earth is medial.

Hydrous - The fine earth has andic soil properties; water at 1500 kPa is 100 percent or more on undried samples of the fine earth; rock fragments make up less than 35 percent by volume.

Hydrous-pumiceous - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are two-thirds or more by volume of the rock fragments; fine earth is hydrous.

Hydrous-skeletal - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are less than two-thirds by volume of the rock fragments; fine earth is hydrous.

Control section for particle-size classes or their substitutes

Names of particle-size classes or their substitutes as defined are applied to specific horizons or to the materials between given limits of depth that are defined in terms of either the distance below the surface of the mineral soil or the upper boundary of a specified horizon or root-limiting layer. The vertical section so defined is called the control section. Root-limiting layers include fragipans, duripans, continuous ortstein, petrocalcic and petrogypsic horizons, and lithic, paralithic, and petroferric contacts. Definitions of the control section for determination of the particle-size classes are arranged as a key.

A. Particle-size modifiers or substitutes are used to describe material from the surface to a root-limiting layer if any of these come within a depth of 36 cm (14 in.) or less; or to a depth of 36 cm if the soil temperature is $0^{\circ}C$ or lower within this depth about 2 months after the summer solstice.

B. In Andisols particle-size modifiers or substitutes are used to describe material from the mineral soil surface or upper boundary of an organic layer that meets andic soil properties, whichever is shallower, to 100 cm or to a lithic, paralithic, or petroferric contact, to a duripan, or to a petrocalcic or placic horizon if the depth to any of these is less than 100 cm; or to a depth 25 cm below the level at which the soil temperature is $0^{\circ}C$ about 2 months after the summer solstice; whichever is shallower.

C. In great groups of Spodosols, Alfisols, and Ultisols that have a spodic horizon or a fragipan in or above an argillic or kandic horizon; in Oxisols; and in other soils that do not have an argillic, kandic, or natric horizon:

1. Particle-size modifiers or substitutes are used to describe material from the base of the Ap horizon or from a depth of 25 cm, whichever is greater, to a root-limiting layer if the depth is less than 100 cm; or to a depth 25 cm below the level at which the soil temperature is $0^{\circ}C$ about 2 months after the summer solstice; whichever is shallower.

2. Otherwise, particle-size modifiers or substitutes are used to describe material from a depth of 25 cm to a depth of 100 cm.

D. In other soils of the orders Alfisols and Ultisols and in great groups of Aridisols and Mollisols that have an argillic or kandic horizon that has (a) a lower boundary deeper than 25 cm (see E) and (b) an upper boundary shallower than 100 cm, or the soil is in a grossarenic subgroup:

1. If there are no strongly contrasting particle-size classes, as defined later, and there is no root-limiting layer between the top of the argillic, kandic, or natric horizon and a depth of 100 cm, particle-size modifiers or substitutes are used to describe the whole argillic, kandic, or natric horizon if it is less than 50 cm thick[6] or the upper 50 cm of the argillic, kandic, or natric horizon if it is more than 50 cm thick.

2. If there are horizons or layers of strongly contrasting particle-size classes, as defined later, within or below the argillic, kandic, or natric horizon and within a depth of 100 cm, particle-size modifiers or substitutes are used to describe material from the top of the argillic, kandic, or natric horizon to a depth of 100 cm or to a root limiting layer, whichever is shallower.

3. If there is a root-limiting layer below an argillic, kandic, or natric horizon, particle-size modifiers or substitutes are used to describe material from the top of the argillic, kandic, or natric horizon, excluding any part incorporated in an Ap horizon, to the top of the root-limiting layer, or are used to describe the upper 50 cm of the argillic, kandic, or natric horizon, whichever of these is less.

E. In other soils in the orders Alfisols and Ultisols and in great groups of Aridisols and Mollisols that have an argillic, kandic, or natric horizon that has its upper boundary at a depth of more than 100 cm and that are not in a grossarenic subgroup, particle-size modifiers or substitutes are applied to describe material from a depth of 25 cm to a depth of 100 cm below the mineral surface.

F. In other soils in which the lower boundary of the argillic or natric horizon is shallower than 25 cm, that is, they have a *k* horizon in which there is soft powdery lime, or have a calcic or other named diagnostic horizon that has its upper boundary within 25 cm of the surface, or have rock structure dominant within that depth, particle-size classes are used to describe material from the top of the argillic horizon or the base of an Ap horizon, whichever is shallower, to a root-limiting layer or to a depth of 100 cm, whichever is shallowest.

<u>Strongly contrasting particle-size classes</u>

In applying names of particle-size classes, the weighted average particle-size class of the control section or of the horizon listed is named unless there are strongly contrasting particle-size classes within the control

---

[6] The upper boundary of the argillic or kandic horizon is not always obvious. If properties of an argillic horizon are present but the upper boundary is gradual, use the depth at which the percentage of clay exceeds that of a higher lying horizon by the appropriate amount after fitting to a smooth curve. If the boundary is irregular or broken, as in A&B or B&A horizons, use the depth at which half or more of the volume has the fabric of an argillic horizon.

29. Hydrous over clayey-skeletal.
30. Hydrous over clayey.
31. Hydrous over fragmental.
32. Hydrous over loamy-skeletal.
33. Hydrous over loamy.
34. Hydrous over sandy or sandy-skeletal.
35. Loamy over sandy or sandy-skeletal if the loamy material has less than 50 percent fine or coarser sand.
36. Loamy-skeletal over clayey if there is an absolute difference of more than 25 percent in the percentage of clay in the fine-earth fraction.
37. Loamy-skeletal over fragmental.
38. Loamy-skeletal over sandy.
39. Medial over ashy.
40. Medial over clayey-skeletal.
41. Medial over clayey.
42. Medial over fragmental.
43. Medial over hydrous.
44. Medial over loamy-skeletal.
45. Medial over loamy.
46. Medial over pumiceous or cindery.
47. Medial over sandy or sandy-skeletal.
48. Pumiceous or ashy-pumiceous over loamy.
49. Pumiceous or ashy-pumiceous over medial-skeletal.
50. Pumiceous or ashy-pumiceous over medial.
51. Pumiceous or ashy-pumiceous over sandy or sandy-skeletal.
52. Sandy over clayey.
53. Sandy over loamy if the loamy material has less than 50 percent fine or coarser sand.
54. Sandy-skeletal over loamy if the loamy material has less than 50 percent fine or coarser sand.

The intent in setting up classes of strongly contrasting particle sizes is to identify changes in pore-size distribution that seriously affect movement and retention of water and that have not been identified in higher categories. The list given is intended for use in grouping the soil series of the United States into families. It is not intended as a complete list. For example, fine sand over coarse sand is common in the Udipsamments of western Europe but is not known to be important in the United States.

Choice of 7 or 11 particle-size classes

Only the seven particle-size classes are used in lithic, arenic, and grossarenic subgroups and in shallow families.

In families of Ultisols not included in the preceding item, subclasses of loamy particle-size classes are used but not subclasses of the clayey classes.

Contrasting families are recognized if substitute terms are used to characterize the materials in a part of the particle-size control section. If the substitute terms are used only for the upper part then only the seven particle-size classes are used. For example, we might use cindery over loamy but not cindery over fine-loamy.

Only two particle-size classes are used to separate families in Vertisols, fine if there is less than 60 percent clay and very-fine if there is 60 percent or more clay in the weighted average of the control section.

Mineralogy classes

The control section

Mineralogy classes are based on the approximate mineralogical composition of selected size fractions of the same segment of the soil (control section) that is used for application of particle-size classes.

Contrasting mineralogy modifiers

Contrasting mineralogy modifiers are not recognized except where substitutes for particle-size class modifiers have been used. In identifying and naming the contrasting mineralogy modifiers in families of those soils, the seven particle-size classes are used to describe the lower part of the section. For example, a pair of contrasting layers is named as medial over loamy, mixed, not medial over coarse-loamy, mixed.

If there are layers of contrasting particle size in the control section, the mineralogy class of the upper part of the control section is definitive of the family mineralogy. For example, if there is fine-loamy material of mixed mineralogy over sandy material that is siliceous, the proper modifiers to describe the family are fine-loamy over sandy, mixed, not fine-loamy, mixed, over sandy, siliceous.

Key to mineralogy classes

All mineral soils, except Oxisols, are placed in the first mineralogy class of the key (Table 1) that accommodates them although they may appear also to meet the requirements of other mineralogy classes. The correct mineralogy class for Oxisols is determined by using the key in Table 2. These are keys, not complete definitions. Substitute terms connoting both particle size and mineralogy are based on combined texture, consistence, and mineralogy classes and are used to indicate important variations in Andisols, in many intergrades to Andisols, and in many cryic great groups and cryic subgroups of Spodosols. Mineralogy classes are not named in Calciaquolls because the effect of the carbonates overshadows other differences in mineralogy, and they are not named in Quartzipsamments, which, by definition, are siliceous.

It is recognized that it is normally impossible to be certain of the percentages of the various kinds of clay minerals. Quantitative methods of identification are still subject to change. Although much progress has been made in the past few decades, an element of judgment enters into the estimation. All the evidence does not need to come from X-ray, surface, and DTA determinations. Other physical and chemical properties suggest the mineralogy of many clayey soils. Changes in volume, cation-exchange capacity, and the consistence are useful in estimating the nature of clay.

The description of clay mineralogy in naming families of clayey soils is based on the weighted average of the control section.

Calcareous and reaction classes

The presence or absence of carbonates and the reaction are treated together because they are so intimately related. A calcareous horizon cannot be strongly acid. Calcareous classes are applied to the section between a depth of 25 and 50 cm or between a depth of 25 cm and a lithic or paralithic contact that is below a depth of 25 but not 50 cm, or to some part of the soil above a lithic or paralithic contact that is shallower than 25 cm. Two classes, calcareous and noncalcareous, are used in selected taxa. The definitions follow.

Calcareous.--The fine-earth fraction effervesces in all parts with cold dilute HCl.

Noncalcareous.--The fine-earth fraction does not effervesce in all parts with cold dilute HCl. The term noncalcareous is not used as a part of a family name.

It should be noted that a soil that contains dolomite is calcareous and that effervescence of dolomite, when treated with cold dilute HCl, is slow.

Reaction classes are applied to the control section that is defined for particle-size classes. Three classes (acid, nonacid, and allic) are used in selected taxa. The definitions follow.

Acid.--The pH is less than 5.0 in 0.01 M $CaCl_2$ (2:1) throughout the control section (about 5.5 in H_2O, 1:1).

Nonacid.--The pH is 5.0 or more in 0.01 M $CaCl_2$ (2:1) in at least some part of the control section. The term nonacid is not used in the family name of calcareous soils.

Allic.--There is more than 2 cmol(+) of KCl-extractable Al per kg soil (less than 2.0 mm fraction) in some 30 cm layer in the control section.

Acid and nonacid classes are used only in names of families of Entisols and Aquepts; they are not used in sandy, sandy-skeletal, and fragmental families of these taxa, nor are they used in Sulfaquepts and Fragiaquepts, or in families that have carbonatic or gypsic mineralogy. The allic class is used only in names of families of Oxisols.

Calcareous classes are used if appropriate in the same taxa as reaction classes and, in addition, are used in families of Aquolls except for Calciaquolls and for Aquolls that have an argillic horizon. Calcareous and reaction classes are not used in soils that have carbonatic or gypsic mineralogy. A soil that is calcareous is never acid. Calcareous therefore implies nonacid, and both names are not used because nonacid would be redundant. Similarly, noncalcareous would be redundant in acid families, and it is not used as part of the family name. If calcareous is used in a family name, calcareous is considered to be a subclass of mineralogy. It follows the mineralogy class name and is shown in parenthesis, for example: fine-loamy, mixed (calcareous), mesic Typic Haplaquolls.

Soil temperature classes

Soil temperature classes, as named and defined here, are used as family differentiae in all orders. The names are used as family modifiers unless the name of a higher taxon carries the same limitation. Thus, frigid is implied in all boric suborders and cryic great groups, and is redundant if used in the name of a family.

The Celsius (centigrade) scale is the standard. Approximate Fahrenheit equivalents are indicated parenthetically. It is assumed that the temperature is that of a soil that is not being irrigated.

For soils in which the difference is 5°C (9°F) or more between mean summer (June, July, and August in the northern hemisphere) and mean winter (December, January, and February in the northern hemisphere) soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, the classes, defined in terms of the mean annual soil temperature, are as follows:

Frigid.--Below 8°C (47°F).

Mesic.--From 8° to 15°C (47° to 59°F).

Thermic.--From 15° to 22° C (59° to 72° F).

Hyperthermic.--22°C (72°F) or higher.

For soils in which the difference is less than 5°C (9°F) between mean summer and mean winter soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, the classes, defined in terms of the mean annual soil temperature, are as follows:

Isofrigid.--Below 8°C (47°F).

Isomesic.--From 8° to 15°C (47° to 59°F).

Isothermic.--From 15° to 22°C (59° to 72°F).

Isohyperthermic.--22°C (72°F) or higher.

The appropriate limit between isofrigid and isomesic cannot be tested in the United States and probably will need to be revised.

Other characteristics

Several soil characteristics other than those already mentioned are needed in particular taxa to provide reasonable groupings of series into families. Some of these seem to be logical family criteria. Others probably should have been used in higher categories, but the lack of information about them makes it much safer to use them as family differentiae at this time. These characteristics include depth of soil, consistence, moisture equivalent, slope of soil, and permanent cracks.

<u>Depth of soil</u>

Classes of shallow and deep soils may be needed at the family level in all the orders of mineral soils. Some distinctions in depth are made in great groups and in arenic, paralithic, and lithic subgroups, but some other soils should also be grouped in families according to depth. Some soils have a paralithic contact over soft rock such as clay shale that is too compact for penetration by roots. The soil depth classes follow:

Micro.--Less than 18 cm through diagnostic horizons. Used in cryic great groups but not in pergelic subgroups or in Entisols.

Shallow.--Two depths are considered shallow:

a. Less than 50 cm to the upper boundary of a duripan or petrocalcic horizon or to a lithic, paralithic or petroferric contact. Used in lithic and petroferric subgroups of Oxisols and all great groups of Alfisols, Aridisols, Entisols, Inceptisols, Mollisols, Spodosols, and Ultisols, except pergelic subgroups of the cryic great groups and lithic subgroups. It is emphasized that the adjective "shallow" is not used in the family name of lithic subgroups of orders, other than Oxisols, because it would be redundant.

b. Less than 100 cm to a lithic or paralithic or a petroferric contact. Used in families of Oxisols.

Slope or shape of soil

Soils of aquic great groups normally have level or concave surfaces. They are mainly in places where ground water saturates the soil during some period of the year. A few, however, are on the sides of slopes where water cannot stand and are kept wet by more or less continuous precipitation and by seepage of water from higher areas. In a very few, the hydrostatic pressure keeps the soil wet. No consistent internal morphological clues have yet been found that distinguish these sloping aquic soils if the dissolved oxygen content is low, but their recognition in the field from the position of the soil in the landscape is generally easy. In aquic great groups, particularly in Aquolls, Aquox, and Aquults, use the shape of the soil as a family differentia. For Aquolls and Aquults use classes of level and sloping as these classes are defined in the Soil Survey Manual. For Aquox use sloping in the names of families if slope is more than 8 percent. It may be necessary to use slope classes as family differentiae in other orders, but they should not be used in families of Aquods or Albaqualfs. Level is assumed in families of aquic soils if no slope modifier is used in the family name.

Consistence

Some cemented horizons, for example, a duripan, are differentiae in the classification in categories above the family. Others such as a cemented spodic horizon (ortstein) are not, but no single family should include soils that have a continuous, shallow, cemented horizon and soils that do not. In Spodosols, in particular, a cemented spodic horizon needs to be used as a family differentia. The following classes of consistence are defined for Spodosols.

Ortstein.--All or part of the spodic horizon is at least weakly cemented, when moist, into a massive horizon that is present in more than half of each pedon.

Noncemented.--The spodic horizon, when moist, is not cemented into a massive horizon in as much as half of each pedon.

Cementation of a small volume into shot or concretions does not constitute cementation to form a massive horizon. The name of a family of noncemented Spodosols normally does not have a modifier to imply lack of cementation. The name of a family of cemented Spodosols contains the modifier "ortstein."

A cemented calcic or gypsic horizon is not identified in the family name. Many calcic and some gypsic horizons

FAMILY DIFFERENTIAE FOR HISTOSOLS

Most of the differentiae used to distinguish families of Histosols have been defined earlier, either because they are differentiae in mineral soils as well as in Histosols; or because their definitions are essential for the classification of some Histosols in categories higher than the family. The differentiae that are not defined elsewhere are defined in this section and the taxa in which they are used are enumerated.

The order in which family modifiers are placed in the technical family names of Histosols follows. The modifiers chosen are those appropriate to the particular family.

Particle size
Mineralogy, including nature of limnic deposits
Reaction
Soil temperature regime
Soil depth

The differentiae are discussed in the remainder of this section.

Particle-size classes

Particle-size modifiers are used in family names of Histosols only in terric subgroups. The terms used follow.

Fragmental
Loamy-skeletal or clayey-skeletal
Sandy or sandy-skeletal
Loamy
Clayey

The meaning of each of these terms is the same as that defined for particle-size classes of mineral soils. The proper term is selected to describe the weighted average particle size of the upper 30 cm of the mineral layer or that part of the mineral layer that is within the control section, whichever is thicker.

Mineralogy classes

Mineralogy classes of Histosols are of three kinds, according to the nature of the subgroup or great group.

Ferrihumic.--Containing ferrihumic materials within the control section (applied to Fibrists, Hemists, and Saprists, except Sphagnofibrists and sphagnic subgroups of other great groups). Bog iron is present in some Histosols or in organic soil materials. It is called ferrihumic material. It consists of authigenic deposits (formed in place) of hydrated iron oxides mixed with varying kinds or amounts of organic materials. The iron in some places is present in large cemented aggregates. In others it may be mostly dispersed and soft. The colors normally are shades of dark reddish brown, commonly mixed with black, and the colors change little on drying. The content of iron oxide ranges from 10 percent to more than 20 percent.

Ferrihumic material either is saturated with water for long periods (more than 6 months) or is in an artificially drained soil. The content of free iron oxide should exceed 10 percent (7 percent Fe), but the horizon may be either organic or mineral provided there is at least 1 percent organic matter. The materials should have more than 2 percent (by weight) concretions of iron, which may range in size from fine (less than 5 mm) to 1 m or more in the largest lateral dimension. Colors should be dark reddish brown or reddish brown, or should be close to those colors. The presence of ferrihumic material within the control section is one of the family differentiae.

If ferrihumic is used as a modifier in the technical family name, no other mineralogy modifier is used because the presence of the iron is considered to be, by far, the most important characteristic.

Modifiers applied only to terric subgroups.–The mineralogy modifiers used for mineral soils are applied to the mineral parts of the soil for which a particle-size modifier has been used if the mineralogy is not ferrihumic.

Modifiers applied to limnic subgroups.–If limnic materials are present in the control section, if they are 5 cm or more thick, and if the materials do not have ferrihumic mineralogy, the following modifiers are used.

Coprogenous. Limnic materials that consist of coprogenous earth are present.

Diatomaceous. Limnic materials that consist of diatomaceous earth are present.

Marly. Limnic materials that consist of marl are present.

Reaction classes

Modifiers to indicate reaction are used in all subgroups. The meanings follow.

Euic.–The pH of undried samples is 4.5 or more (0.01 M $CaCl_2$) in at least some part of the organic materials in the control section.

Dysic.–The pH is less than 4.5 (in 0.01 M $CaCl_2$) in all parts of the organic materials in the control section.

Soil temperature classes

Names and definitions of classes follow the rules given for soil temperature classes of mineral soils. Frigid, however, is redundant in boric and cryic great groups and is not used. No temperature modifier is used in pergelic subgroups.

Soil depth classes

Soil depth modifiers are used in all lithic subgroups of Histosols except in the suborder of Folists. It is assumed that lithic Folists have a shallow lithic contact. Other lithic Histosols have a lithic contact within the control section but it may be as much as 160 cm deep.

Shallow families.--Used in lithic subgroups to indicate a lithic contact between a depth of 18 cm and 50 cm.

Micro families.--Used to indicate a lithic contact shallower than 18 cm without regard to soil temperature. (In mineral soils, micro families are restricted to cryic great groups.)

LITERATURE CITED

Soil Survey Staff. 1951. Soil survey manual. U.S. Dept. Agr. Handb. 18. U.S. Govt. Printing Office, Washington, DC.

TABLE 1 - KEY TO MINERALOGY CLASSES
(except for Oxisols - see Table 2)

CLASSES APPLIED TO SOILS OF ANY PARTICLE-SIZE CLASS

Carbonatic
Definition: More than 40% by weight carbonates (expressed as $CaCO_3$) plus gypsum, and the carbonates are more than 65% of the sum of carbonates and gypsum.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter or whole soil less than 20 mm, whichever has highest percentage of carbonates plus gypsum.

Ferritic
Definition: More than 40 % by weight iron oxide extractable by citrate-dithionite, reported as Fe_2O_3 (or 28% reported as Fe).

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

Gibbsitic
Definition: More than 40% by weight hydrated aluminum oxides, reported as gibbsite and bohemite.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

Oxidic
Definition: Less than 90% quartz; less than 40% any other single mineral listed subsequently; and the ratio, percent extractable iron oxide plus percent gibbsite to percent clay[8] is 0.20 or more. That is,

$$\frac{\text{extractable } Fe_2O_3 \text{(pct.)} + \text{gibbsite (pct.)}}{\text{clay (pct.)}} \geq 0.2$$

Determinant size fraction: For quartz and other minerals, fraction 0.02 to 2.0 mm in diameter; for ratio of iron oxide and gibbsite to clay, whole soil less than 2.0 mm.

Serpentinitic
Definition: More than 40% by weight serpentine minerals (antigorite, chrysotile, fibrolite, and talc).

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

---

[8] Percentage of clay or percentage of 1500 kPa water retention times 2.5, whichever is greater, provided the ratio of 1500 kPa water retention to clay is 0.6 or more in half or more of the control section.

Gypsic
Definition: More than 40% by weight of carbonates (expressed as $CaCO_3$) plus gypsum, and the gypsum is more than 35% of the sum of carbonates and gypsum.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter, or whole soil less than 20 mm, whichever has higher percentage of carbonates plus gypsum.

Glauconitic
Definition: More than 40% glauconite by weight.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

CLASSES APPLIED TO SOILS THAT HAVE A FRAGMENTAL, SANDY, SANDY-SKELETAL, LOAMY, OR LOAMY-SKELETAL PARTICLE SIZE CLASS

Micaceous
Definition: More than 40% mica by weight[9]

Determinant size fraction: 0.02 to 20 mm.

Siliceous
Definition: More than 90% by weight[10] of silica minerals (quartz, chalcedony, or opal) and other extremely durable minerals that are resistant to weathering.

Determinant size fraction: 0.02 to 2.0 mm.

Mixed
Definition: All others that have less than 40% of any one mineral other than quartz or feldspars.

Determinant size fraction: 0.02 to 2.0 mm.

CLASSES APPLIED TO SOILS THAT HAVE A CLAYEY OR CLAYEY-SKELETAL PARTICLE-SIZE CLASS

Halloysitic
Definition: More than half halloysite[11] by weight and smaller amounts of allophane or kaolinite or both.

Determinant size fraction: Less than 0.002 mm.

---

[9] Percentages by weight are estimated from grain counts. Usually, a count of one or two of the dominant size fractions of a conventional mechanical analysis is sufficient for placement of the soil.

[10] Percentages by weight are estimated from grain counts. Usually, a count of one or two of the dominant size fractions of a conventional mechanical analysis is sufficient for placement of the soil.

[11] Halloysite as used here includes only the tubular forms. What has been called tabular halloysite is grouped here with kaolinite.

Chapter 4

Identification of the Taxonomic Class of a Soil

KEY TO SOIL ORDERS

In this key and the other keys that follow, the diagnostic horizons and the properties mentioned do not include the properties of buried soils except their organic carbon if of Holocene age, andic soil properties, and base saturation. Properties of buried soils are considered in the categories of subgroups, families, and series but not in those of order, suborder, and great group. The meaning of the term "buried soil" is given in chapter 1.

A. Soils that *either*

1. Have organic soil materials that extend from the surface to one of the following:

a. A depth within 10 cm or less of a lithic or paralithic contact, provided the thickness of the organic soil materials is more than twice that of the mineral soil above the contact; *or*

b. Any depth if the organic soil material rests on fragmental material (gravel, stones, cobbles) and the interstices are filled with organic materials, or rests on a lithic or paralithic contact; *or*

2. Have organic materials that have an upper boundary within 40 cm of the surface, *and*

a. Have one of the following thicknesses:

(1) 60 cm or more if three-fourths or more of the volume is moss fibers or the moist bulk density is less than 0.1 g per cubic centimeter (6.25 lbs per cubic foot); *or*

(2) 40 cm or more if

(a) The organic soil material is saturated with water for long periods (more than 6 months) or is artificially drained; *and*

(b) The organic material consists of sapric or hemic materials or consists of fibric materials that are less than three-fourths moss fibers by volume and have a moist bulk density of 0.1 or more; *and*

b. Have organic soil materials that

(1) Do not have a mineral layer as much as 40 cm thick either at the surface or whose upper boundary is within a depth of 40 cm from the surface; *and*

(2) Do not have mineral layers, taken cumulatively, as thick as 40 cm within the upper 80 cm; *and*

c. Do not have andic soil properties in layers 35 cm or more thick within a depth of 60 cm from the surface.

Histosols, p. 225

B. Other soils that have andic soil properties throughout subhorizons, whether buried or not, which have a cumulative thickness of 35 cm or more within 60 cm of the mineral soil surface or upper boundary of an organic layer that meets andic soil properties, whichever is shallower.

Andisols, p. 129

C. Other soils that do not have a plaggen epipedon but that have *either*:

1. A spodic horizon whose upper boundary is within 200 cm of the surface; *or*

2. A placic horizon that meets all the requirements of a spodic horizon except thickness and index of accumulation and rests on a fragipan, on a spodic horizon, or on an albic horizon that rests on a fragipan.

Spodosols, p. 357

D. Other soils that have *either*:

1. An oxic horizon with its upper boundary within 150 cm of the soil surface, and do not have a clay content increase necessary to define the upper boundary of a kandic horizon within a depth of 150 cm of the soil surface, *or*

2. 40 percent or more clay in the surface 18 cm, after mixing, and, with its upper boundary within 150 cm of the soil surface, either an oxic horizon, or a kandic horizon that meets the weatherable mineral requirements of an oxic horizon.

Oxisols, p. 335

E. Other soils that

1. Do not have a lithic or paralithic contact, petrocalcic horizon, or duripan within 50 cm of the surface; *and*

2. After the soil to a depth of 18 cm has been mixed, as by plowing, have 30 percent or more clay in all subhorizons to a depth of 50 cm or more; *and*

3. Have, at some time in most years unless irrigated or cultivated, open cracks[1] at a depth of 50 cm that are at least 1 cm wide and extend upward to the surface or to the base of the plow layer or surface crust; *and*

4. Have one or more of the following:

a. Gilgai; *or*

b. At some depth between 25 and 100 cm, slickensides close enough to intersect; or

c. At some depth between 25 and 100 cm, wedge-shaped natural structural aggregates that have their long axes tilted 10 to 60° from the horizontal.

Vertisols, p. 407

F. Other soils that have an ochric or anthropic epipedon and *either*:

1. Do *not* have an argillic or a natric horizon *but*

a. Are saturated with water within 100 cm of the surface for 1 month or more in some years and have a salic horizon whose upper boundary is within 75 cm of the surface; *or*

b. Have one or more of the following horizons whose upper boundary is within 100 cm of the soil surface: a petrocalcic, calcic, gypsic, petrogypsic, or cambic horizon or a duripan; and have an aridic moisture regime; *or*

2. Have an argillic or a natric horizon and have

a. An aridic moisture regime; *and*

b. An epipedon that is not both massive and hard or very hard when dry.

Aridisols, p. 159

G. Other soils that have a mesic, isomesic, or warmer temperature regime, do not have tongues of albic materials in the argillic horizon that have vertical dimensions of as much as 50 cm if there are more than 10 percent weatherable minerals in the 20- to 200-micron fraction, but have one of the following combinations of characteristics: *either*

---

[1] An open crack is interpreted to be a separation between gross polyhedrons. If the surface horizons are strongly self-mulching, that is, if the soil is a mass of loose granules, or if the soil is cultivated while the cracks are open, the cracks may be largely filled with granular materials from the surface. But they are considered to be open in the sense that the polyhedrons are separated.

1. Have an argillic or kandic horizon but not a fragipan and have base saturation (by sum of cations) of less than 35 percent at the following depths: *either*

a. If the argillic or kandic horizon has in some part a hue of 5YR or yellower, or a color value, moist, of 4 or more, or a color value, dry, that is more than 1 unit higher than the value, moist, the shallowest of the following:

(1) 125 cm below the upper boundary of the argillic or kandic horizon; *or*

(2) 180 cm below the surface of the soil; *or*

(3) Immediately above a lithic or paralithic contact; *or*

b. If the argillic or kandic horizon has some other color or if the epipedon has a sandy or sandy-skeletal particle-size class throughout, the deepest of 125 cm below the upper boundary of the argillic horizon, 180 cm below the surface of the soil, or immediately above a lithic or a paralithic contact if it is shallower; *or*

2. Have a fragipan that

a. Meets all the requirements of an argillic or kandic horizon or has clay skins more than 1 mm thick in some part, or underlies an argillic or kandic horizon; *and*

b. Has base saturation (by sum of cations) of less than 35 percent at a depth of 75 cm below the upper boundary of the fragipan or immediately above a lithic or paralithic contact, whichever is shallower.
Ultisols, p. 373

H. Other soils that

1. Have *either*:

a. A mollic epipedon; *or*

b. A surface horizon that, after the soil to a depth of 18 cm is mixed, meets all requirements of a mollic epipedon except thickness, and, in addition, an upper subhorizon more than 7.5 cm thick that is in an argillic, kandic or a natric horizon, that meets the requirements of a mollic epipedon with respect to color, content of organic carbon, base saturation, and structure but is separated from the surface horizon by an albic horizon; *and, in addition,*

2. Have base saturation of 50 percent or more (by NH_4OAc) as follows: *either*

a. If there is an argillic, kandic or natric horizon, from its upper boundary to a depth of 125 cm below that boundary, or to a depth 180 cm below the soil surface or to a lithic or paralithic contact, whichever is least; *or*

b. If there is no argillic, kandic, or natric horizon, in all subhorizons to a depth 180 cm below the soil surface or to a lithic or paralithic contact, whichever is least.

Mollisols, p. 275

I. Other soils that *either*

1. Have an argillic, kandic or natric horizon but no fragipan; *or*

2. Have a fragipan that

a. Is in or underlies an argillic or kandic horizon; *or*

b. Meets all requirements of an argillic or kandic horizon; *or*

c. Has clay skins more than 1 mm thick in some part.

Alfisols, p. 73

J. Other soils that have no sulfidic material within 50 cm of the mineral soil surface; and have between 20 and 50 cm below the mineral soil surface an *n* value of 0.7 or less in one or more subhorizons or less than 8 percent clay in one or more subhorizons; and have *one or more* of the following:

1. An umbric, mollic, histic (either mineral or organic) or plaggen epipedon; *or*

2. A cambic horizon or both an aquic moisture regime and permafrost; *or*

3. Within 100 cm of the surface, a calcic, petrocalcic, gypsic, petrogypsic, or placic horizon or a duripan; *or*

4. A fragipan or an oxic horizon with its upper boundary between a depth of 150 and 200 cm; *or*

5. A sulfuric horizon whose upper boundary is within 50 cm of the soil surface; *or*

6. In half or more of the upper 50 cm, an SAR of 13[2] or more (or sodium saturation that is 15 percent or more) that decreases with depth below 50 cm and, within a depth of 100 cm, have ground water at some period during the year when the soil is not frozen in any part.
Inceptisols, p. 241

K. Other soils.
Entisols, p. 195

---

[2] The percentage of exchangeable sodium (ESP) is used in the definition of the natric horizon and in a number of the taxa. Since this text was written, the U.S. Salinity Laboratory (personal communication from C. A. Bower) has revised its definition of sodic (alkali) soils and the method for measuring the sodium adsorption ratio (SAR) as follows: SAR is measured by the normal method if the conductivity (EC) of the saturation extract is less than 20 dS per m at 25°C. If the conductivity is 20 mmhos or more and SAR is more than 10, SAR is determined on a sample that has been leached with distilled water until EC of the leachate decreases to about 4 mmhos per centimeter but not to less than 4. ESP of 15 or more is replaced by SAR of 13 or more if EC is large enough to require a correction for soluble salts in calculating ESP. If EC is low enough (4 or less) that no correction is needed for soluble salts, ESP is determined directly from the replaced cations.

Chapter 5

Alfisols

KEY TO SUBORDERS

IA. Alfisols that have an aquic moisture regime or are artificially drained and that have characteristics associated with wetness, namely, mottles, or iron-manganese concretions more than 2 mm in diameter, or chroma of 2 or less immediately below any Ap horizon or below any dark A horizon in which the moist color value is 3 or less after the material is rubbed, and one of the following:

1. Dominant chroma of 2 or less[1] in coatings on the surface of peds and mottles within peds of the argillic or kandic horizon, or a dominant chroma of 2 or less in the matrix of the argillic or kandic horizon and mottles of higher chroma; *or*

2. If there are no mottles in the argillic or kandic horizon, a dominant chroma of 1 or less.

Aqualfs, p. 74

IB. Other Alfisols that have

1. A frigid temperature regime but do not have a xeric moisture regime; *or*

2. A cryic temperature regime.

Boralfs, p. 84

IC. Other Alfisols that have one of the following:

1. An ustic moisture regime; *or*

2. An epipedon that is both massive and hard or very hard when dry, and a moisture regime that is aridic but marginal to ustic.

Ustalfs, p. 106

ID. Other Alfisols that have one of the following:

1. A xeric moisture regime; *or*

---

1 If the hue is redder than 10YR because of red parent materials that remain red after citrate-dithionite extraction, the requirement for low chroma is waived. Where the soil temperature regime is hyperthermic, isothermic, or isohyperthermic, chroma up to 4 is tentatively permitted if the hue is 2.5Y or 5Y and if mottles are distinct or prominent. Such soils are too few in the United States to permit testing these limits.

2. An epipedon that is both massive and hard or very hard when dry, and a moisture regime that is aridic but marginal to xeric.

Xeralfs, p.119

IE. Other Alfisols that have a udic moisture regime.

Udalfs, p. 91

AQUALFS

Key to great groups

IAA. Aqualfs that have plinthite that forms a continuous phase or constitutes half or more of the matrix within some subhorizon between 30 and 150 cm below the surface of the soil.

Plinthaqualfs, p. 83

IAB. Other Aqualfs that have a natric horizon and do not have a duripan.

Natraqualfs, p. 80

IAC. Other Aqualfs that have a duripan.

Duraqualfs, p. 77

IAD. Other Aqualfs that have a fragipan.

Fragiaqualfs, p. 77

IAE. Other Aqualfs that have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kandiaqualfs, p.78

IAF. Other Aqualfs that have an albic horizon tonguing into an argillic horizon.

Glossaqualfs, p. 77

IAG. Other Aqualfs that have an abrupt textural change between an ochric epipedon or an albic horizon and an argillic horizon and have slow or very slow hydraulic conductivity in the argillic horizon.[2]

Albaqualfs, p. 75

IAH. Other Aqualfs that have an umbric epipedon.

Umbraqualfs, p. 83

---

[2] Hydraulic conductivity is defined as the rate of internal water movement under a unit potential gradient. In this text the term refers to vertical saturated hydraulic conductivity. Slow and very slow rates refer to 4 to 10 and less than 4 cm water per day, respectively.

IAI. Other Aqualfs.

Ochraqualfs, p. 80

Albaqualfs

Key to subgroups

IAGA. Albaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Albaqualfs

IAGB. Other Albaqualfs that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap or an albic horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the soil to a depth of 100 cm or in the whole soil if the depth to a lithic or paralithic contact is more than 50 cm but less than 100 cm; *and*

   c. More than 35 percent clay in horizons that have a total thickness of more than 50 cm; *and*

2. Have a surface horizon that, after the soil to a depth of 18 cm has been mixed, has 30 percent or more clay and is discontinuous throughout each pedon.

Ruptic-Vertic Albaqualfs

IAGC. Other Albaqualfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap or an albic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the soil to a depth of 100 cm or in the whole soil if the depth to a lithic or paralithic contact is more than 50 cm but less than 100 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.

Vertic Albaqualfs

IAGD. Other Albaqualfs that:

Duraqualfs

Duraqualfs are the Aqualfs that have a duripan below the argillic horizon. They are not known to occur in the United States. The group has been proposed for other countries, but definitions of subgroups have not been suggested.

Fragiaqualfs

Key to subgroups

IADA. Fragiaqualfs that have a mottled horizon between the A or Ap horizon and a fragipan that has dominant chroma more than 2 if the hue is 10YR or redder or more than 3 if the hue is 2.5Y or yellower.

Aeric Fragiaqualfs

IADB. Other Fragiaqualfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the surface.

Plinthic Fragiaqualfs

IADC. Other Fragiaqualfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed and smoothed; or the upper soil to a depth of 18 cm, after mixing, has these color values.

Umbric Fragiaqualfs

IADD. Other Fragiaqualfs.

Typic Fragiaqualfs

Glossaqualfs

Key to subgroups

IAFA. Glossaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Glossaqualfs

IAFB. Other Glossaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Glossaqualfs

IAFC. Other Glossaqualfs that have in more than 40 percent of the matrix[3] in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one* of the following:

1. If mottled, the value, moist, is 4 or more and the chroma, moist, is 3 or more; *or*

2. If not mottled, the chroma, moist, is 2 or more.
Aeric Glossaqualfs

IAFD. Other Glossaqualfs that have an Ap horizon that has a color value, moist, of 3 or less, and a color value, dry, of 5 or less after the soil has been crushed and smoothed; or the soil to a depth of 18 cm, after mixing, has these colors.
Mollic Glossaqualfs

IAFE. Other Glossaqualfs.
Typic Glossaqualfs

Kandiaqualfs

Key to subgroups

IAEA. Kandiaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.
Arenic Kandiaqualfs

IAEB. Other Kandiaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.
Grossarenic Kandiaqualfs

IAEC. Other Kandiaqualfs that have a horizon within 150 cm of the soil surface that has 5 percent or more plinthite by volume.
Plinthic Kandiaqualfs

IAED. Other Kandiaqualfs that:

1. Have in more than 40 percent of the matrix in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

   a. If mottled and the mean annual soil temperature is lower than 15°C, chroma, moist, of 3 or more; *or*

---

[3] If the hue is 7.5YR or redder and if peds are present, ped exteriors in the argillic horizon should have dominant chroma, moist, of 1 or less and ped interiors should have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, should be 1 or less immediately below any surface horizon that has color value, moist, of 3 or less.

Natraqualfs

Key to subgroups

IABA. Natraqualfs that

1. Have *tonguing or interfingering* of albic materials more than 2.5 cm into the natric horizon; *and*

2. Have, in all horizons within 40 cm of the soil surface, less than 15 percent saturation with sodium and less magnesium and sodium than calcium and extractable acidity.

Albic Glossic Natraqualfs

IABB. Other Natraqualfs that have less than 15 percent saturation with sodium, and have less magnesium and sodium than calcium and extractable acidity, throughout the upper 15 cm of the natric horizon or in all horizons within 40 cm of the soil surface, whichever is deeper.

Albic Natraqualfs

IABC. Other Natraqualfs that have tonguing or interfingering of albic materials more than 2.5 cm into the natric horizon.

Glossic Natraqualfs

IABD. Other Natraqualfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed and smoothed; or the soil to a depth of 18 cm, after mixing, has these colors.

Mollic Natraqualfs

IABE. Other Natraqualfs.

Typic Natraqualfs

Ochraqualfs

Key to subgroups

IAIA. Ochraqualfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

IAIG. Other Ochraqualfs that have in more than 40 percent of the matrix[6] in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

1. If mottled and the mean annual soil temperature is lower than 15°C, chroma, moist, of 3 or more; *or*

2. If mottled and the mean annual soil temperature is 15°C or more:

   a. If the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma is 3 or more; *or*

   b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

   c. If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

3. If not mottled, the chroma, moist, is 2 or more.

Aeric Ochraqualfs

IAIH. Other Ochraqualfs that have an Ap horizon that meets all the requirements of a mollic epipedon except thickness; or the upper soil to a depth of 18 cm, after mixing, meets these requirements.

Mollic Ochraqualfs

IAII. Other Ochraqualfs that have an Ap horizon that meets all the requirements of an umbric epipedon except thickness; or the upper soil to a depth of 18 cm, after mixing, meets these requirements.

Umbric Ochraqualfs

IAIJ. Other Ochraqualfs.

Typic Ochraqualfs

Plinthaqualfs

Plinthaqualfs are the Aqualfs that have plinthite that forms a continuous phase or that constitutes half or more of the matrix of some subhorizon of the argillic horizon within 150 cm of the soil surface.

Umbraqualfs

Key to subgroups

IAHA. Umbraqualfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

---

[6] If the hue is 7.5YR or redder and if peds are present, ped exteriors in the argillic horizon should have dominant chroma, moist, of 1 or less and ped interiors should have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, should be 1 or less immediately below any surface horizon that has color value, moist, of 3 or less.

pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either:*

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Cryoboralfs

IBDE. Other Cryoboralfs that have mottles that have chroma of 2 or less within 75 cm of the surface, or the soils are continuously saturated with water for 3 months or longer within 100 cm of the surface where undrained.
Aquic Cryoboralfs

IBDF. Other Cryoboralfs that have an argillic horizon that has a texture that is loamy fine sand or coarser or is discontinuous vertically in the upper 15 cm (in lamellae).
Psammentic Cryoboralfs

IBDG. Other Cryoboralfs that have an Ap horizon that has a color value, moist, of 3 or less, or the upper soil has a moist color value of 3 or less after mixing to a depth of 15 cm.
Mollic Cryoboralfs

IBDH. Other Cryoboralfs that have albic materials tonguing in an argillic horizon.
Glossic Cryoboralfs

IBDI. Other Cryoboralfs.
Typic Cryoboralfs

Eutroboralfs

Key to subgroups

IBEA. Eutroboralfs that have a lithic contact within 50 cm of the surface.
Lithic Eutroboralfs

IBEB. Other Eutroboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable iron of more than 1.0 percent.
Andic Eutroboralfs

IBEC. Other Eutroboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil, and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either:*

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Eutroboralfs

IBED. Other Eutroboralfs that:

1. Have an argillic horizon that has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface ; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of the argillic horizon that is more than 50 cm below the soil surface.

Aquic Arenic Eutroboralfs

IBEE. Other Eutroboralfs that:

1. Have an argillic horizon that *either*

a. Has its upper boundary at less than 50 cm below the soil surface and has mottles that have chroma of 2 or less in the upper 25 cm if the mottled layer is saturated with water at some time when the soil temperature is 5°C or higher; *or*

b. Has an upper boundary at 50 cm or more, and the soil has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have tongues of albic materials in the argillic horizon (interfingering is permitted).

Glossaquic Eutroboralfs

IBEF. Other Eutroboralfs that have an argillic horizon that *either:*

1. Has its upper boundary at less than 50 cm below the soil surface, and has mottles that have chroma of 2 or less in the upper 25 cm if the mottled layer is saturated with water at some time when the soil temperature is 5°C or higher; *or*

2. Has an upper boundary at 50 cm or more, and the soil

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragiboralfs

IBBC. Other Fragiboralfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, and are saturated with water at some time within that depth when the soil temperature at a depth of 50 cm is 5°C or more.

Aquic Fragiboralfs

IBBD. Other Fragiboralfs.

Typic Fragiboralfs

Glossoboralfs

Key to subgroups

IBFA. Glossoboralfs that have a lithic contact within 50 cm of the soil surface.

Lithic Glossoboralfs

IBFB. Other Glossoboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Glossoboralfs

IBFC. Other Glossoboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Glossoboralfs

IBFD. Other Glossoboralfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon if the mottled horizons are saturated with water at a time when the soil temperature is 5°C or higher.

Aquic Glossoboralfs

IBFE. Other Glossoboralfs that have an argillic horizon that has a texture that is loamy fine sand or coarser or is discontinuous vertically in the upper 15 cm (in lamellae).
Psammentic Glossoboralfs

IBFF. Other Glossoboralfs that do not have tongues of albic materials in the argillic horizon.
Eutric Glossoboralfs

IBFG. Other Glossoboralfs.
Typic Glossoboralfs

Natriboralfs

Natriboralfs are the Boralfs that have a natric horizon. They are rare in the United States, and subgroups have not been developed.

Paleboralfs

Key to subgroups

IBAA. Paleboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.
Andic Paleboralfs

IBAB. Other Paleboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Paleboralfs

IBAC. Other Paleboralfs that have mottles that have chroma of 2 or less within 100 cm of the surface.
Aquic Paleboralfs

IBAD. Other Paleboralfs that have an argillic horizon that has an increase in clay content of 20 percent or more (absolute) within a vertical distance of 7.5 cm from its upper boundary.

Abruptic Paleboralfs

IBAE. Other Paleboralfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil to a depth of 18 cm has these colors after mixing.

Mollic Paleboralfs

IBAF. Other Paleboralfs.

Typic Paleboralfs

UDALFS

Key to great groups

IEA. Udalfs that have an agric horizon.

Agrudalfs, p. 93

IEB. Other Udalfs that have a natric horizon.

Natrudalfs, p. 102

IEC. Other Udalfs that

1. Do not have a continuous albic horizon above the argillic horizon; *and*

2. Have a broken upper boundary of the argillic horizon; *and*

3. Have discrete nodules in the argillic horizon that range from 2.5 to 30 cm in diameter; exteriors of nodules are enriched and weakly cemented or indurated with iron and have redder hue or stronger chroma than interiors of nodules.

Ferrudalfs, p. 93

IED. Other Udalfs that have tongues of albic materials in the argillic horizon and do not have a fragipan.

Glossudalfs, p. 95

IEE. Other Udalfs that have tongues of albic materials in the argillic horizon and have a fragipan.

Fraglossudalfs, p. 95

IEF. Other Udalfs that have a fragipan.

Fragiudalfs, p. 93

IEG. Other Udalfs that

1. Have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4 OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm

3. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil, after mixing to a depth of 18 cm, has those colors.

Umbreptic Fragiudalfs

IEFB. Other Fragiudalfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil, after mixing to a depth of 18 cm, has those colors.

Mollic Fragiudalfs

IEFC. Other Fragiudalfs that:

1. Have, immediately above the fragipan, thick skeletans of clean sand and silt on primary ped faces, or have an eluvial horizon (E') that has thick skeletans and as much as 3 percent (absolute) less clay than both the overlying and underlying horizons; *and*

2. Have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons.

Glossaquic Fragiudalfs

IEFD. Other Fragiudalfs that:

1. Do not have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds, or both; *and*

2. Have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons.

Aqueptic Fragiudalfs

IEFE. Other Fragiudalfs that:

1. Have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons; *and*

2. Have, within a vertical distance of 7.5 cm at the top of the argillic horizon, a clay increase of more than 15 percent (absolute) in the fine-earth fraction.

Albaquic Fragiudalfs

IEFF. Other Fragiudalfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons.

Aquic Fragiudalfs

IEFG. Other Fragiudalfs that have, immediately above the fragipan, thick skeletans of clean sand and silt on primary ped faces, or have an eluvial horizon (E') that has thick skeletans and as much as 3 percent (absolute) less clay than both the overlying and underlying horizons.

Glossic Fragiudalfs

IEFH. Other Fragiudalfs that do not have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds.

Ochreptic Fragiudalfs

IEFI. Other Fragiudalfs.

Typic Fragiudalfs

Fraglossudalfs

Key to subgroups

IEEA. Fraglossudalfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, and the mottled horizons are saturated with water at some season when the soil temperature is 5°C or higher.

Aquic Fraglossudalfs

IEEB. Other Fraglossudalfs.

Typic Fraglossudalfs

Glossudalfs

Key to subgroups

IEDA. Glossudalfs that have a brittle matrix in one-fourth or more of some subhorizon that is at least 10 cm thick and that has an upper boundary within 125 cm of the surface.

Fragic Glossudalfs

IEDB. Other Glossudalfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, and the mottled horizons are saturated with water at some season when their temperature is 5°C or higher.

Aquic Glossudalfs

and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Hapludalfs

IEKE. Other Hapludalfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Hapludalfs

IEKF. Other Hapludalfs that:

1. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammaquentic Hapludalfs

IEKG. Other Hapludalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Hapludalfs

IEKH. Other Hapludalfs that:

1. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Aquic Arenic Hapludalfs

IEKI. Other Hapludalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Hapludalfs

IEKJ. Other Hapludalfs that:

1. Have an abrupt textural change and mottles in the upper 25 cm of the argillic horizon; *and*

2. Have an argillic horizon that:

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

3. Have base saturation (by sum of cations) of less than 60 percent at a depth 125 cm below the top of the argillic horizon, or 180 cm below the soil surface, or immediately above a lithic or paralithic contact, whichever is least.

Albaquultic Hapludalfs

IEKK. Other Hapludalfs that:

1. Have an abrupt textural change and mottles in the upper 25 cm of the argillic horizon; *and*

2. Have an argillic horizon that:

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface.

Albaquic Hapludalfs

IEKL. Other Hapludalfs that:

1. Have interfingering of albic materials and albic materials surrounding some peds in the upper part of the argillic horizon; *and*

2. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface.

Glossaquic Hapludalfs

IEKM. Other Hapludalfs that:

1. Have an argillic horizon that:

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have base saturation (by sum of cations) of less than 60 percent at a depth 125 cm below the top of the argillic horizon, or 180 cm below the soil surface, or immediately above a lithic or paralithic contact, whichever is least.

Aquultic Hapludalfs

IEKN. Other Hapludalfs that:

1. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water

IEGG. Other Kandiudalfs that have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiudalfs

IEGH. Other Kandiudalfs that have throughout the argillic or kandic horizon a hue of 2.5YR *or redder* and have a value, moist, of 3 or less and have a value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kandiudalfs

IEGI. Other Kandiudalfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed, or the upper soil, after mixing to a depth of 18 cm, has these color values.

Mollic Kandiudalfs

IEGJ. Other Kandiudalfs.

Typic Kandiudalfs

Kanhapludalfs

Key to subgroups

IEHA. Kanhapludalfs that have a lithic contact within 50 *cm of* the soil surface.

Lithic Kanhapludalfs

IEHB. Other Kanhapludalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Kanhapludalfs

IEHC. Other Kanhapludalfs that have throughout the argillic or kandic horizon a hue of 2.5YR or redder and have a value, moist, of 3 or less and have a value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kanhapludalfs

IEHD. Other Kanhapludalfs.

Typic Kanhapludalfs

Natrudalfs

Key to subgroups

IEBA. Natrudalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil, or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Natrudalfs

IEBB. Other Natrudalfs that have tonguing or interfingering of albic materials more than 2.5 cm into the natric horizon.

Glossic Natrudalfs

IEBC. Other Natrudalfs that have an Ap horizon that has a color value, moist, of 2 or less, or the soil to a depth of 18 cm, after mixing, has that color value.

Mollic Natrudalfs

IEBD. Other Natrudalfs that do not have mottles that have chroma of 2 or less within 25 cm of the upper boundary of the natric horizon.

Aeric Natrudalfs

IEBE. Other Natrudalfs.

Typic Natrudalfs

Paleudalfs

Key to subgroups

IEIA. Paleudalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil, or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Paleudalfs

IEIB. Other Paleudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil

temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthaquic Paleudalfs

IEIC. Other Paleudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have subhorizons in the upper part of the argillic horizon that have skeletans that

a. Have moist chroma of 2 or less; *and*

b. Occupy 5 percent or more of the volume of the subhorizon.

Glossaquic Paleudalfs

IEID. Other Paleudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have an increase of 15 percent clay or more (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon.

Albaquic Paleudalfs

IEIE. Other Paleudalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Paleudalfs

IEIF. Other Paleudalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Paleudalfs

IEIG. Other Paleudalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Grossarenic Plinthic Paleudalfs

IEIH. Other Paleudalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Paleudalfs

IEII. Other Paleudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Paleudalfs

IEIJ. Other Paleudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Paleudalfs

IEIK. Other Paleudalfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the surface.

Plinthic Paleudalfs

IEIL. Other Paleudalfs that *either*:

1. Have subhorizons in the upper part of the argillic horizon that have skeletans that

a. Have moist chroma of 2 or less; *and*

b. Occupy 5 percent or more of the volume of the subhorizon; *or*

2. Have albic materials that constitute as much as 5 percent of some subhorizon of the argillic horizon.

Glossic Paleudalfs

IEIM. Other Paleudalfs that have throughout the argillic or kandic horizon a hue of 2.5YR or redder, and have a value, moist, of 3 or less and have a value, dry, that is no more than one unit higher than the value, moist.

Rhodic Paleudalfs

IEIN. Other Paleudalfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, no more than 1 unit higher than the value, moist, or the soil, after mixing to a depth of 18 cm, has these color values.

Mollic Paleudalfs

IEIO. Other Paleudalfs.

Typic Paleudalfs

Rhodudalfs

Rhodudalfs are dark red Udalfs of midlatitudes that have a thinner solum than the Paleudalfs. The definition is parallel to that of other Rhodic great groups. Their parent materials are basic. These soils are rare in the United States. Definitions of subgroups have not been developed.

USTALFS

Key to great groups

ICA. Ustalfs that have a duripan that has its upper boundary within 100 cm of the surface.

Durustalfs, p. 108

ICB. Other Ustalfs that have plinthite that forms a continuous phase or constitutes more than half the matrix within some subhorizon of the argillic horizon within 150 cm of the surface.

Plinthustalfs, p. 118

ICC. Other Ustalfs that have a natric horizon.

Natrustalfs, p. 114

ICD. Other Ustalfs that

1. Have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

2. Do not have a lithic, paralithic or petroferric contact within 150 cm of the soil surface; *and*

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiustalfs, p.111

Durustalfs

Durustalfs are the Ustalfs that have a duripan whose upper boundary is within 100 cm of the surface. They are not known to occur in the United States, and subgroups have not been developed. They are provided for use in other countries.

Haplustalfs

Key to subgroups

ICHA. Haplustalfs that have a lithic contact within 50 cm of the soil surface.

Lithic Haplustalfs

ICHB. Other Haplustalfs that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Udertic Haplustalfs

ICHC. Other Haplustalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm

long in some part, and that extend to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplustalfs

ICHD. Other Haplustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year or the soil has artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Aquic Arenic Haplustalfs

ICHE. Other Haplustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year or the soil has artificial drainage; *and*

2. Have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent throughout.

Aquultic Haplustalfs

ICHF. Other Haplustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year or the soil has artificial drainage.

Aquic Haplustalfs

ICHG. Other Haplustalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Haplustalfs

ICHH. Other Haplustalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, or isomesic or a warmer iso-temperature regime, the soils are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Arenic Aridic Haplustalfs

ICHI. Other Haplustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Haplustalfs

ICHJ. Other Haplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, or isomesic or a warmer iso-temperature regime, the soils are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Haplustalfs

ICHK. Other Haplustalfs that have CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon or in the major part of the upper 100 cm if the argillic horizon is more than 100 cm thick.

Kanhaplic Haplustalfs

ICHL. Other Haplustalfs that have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Haplustalfs

ICHM. Other Haplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in

some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Haplustalfs

ICHN. Other Haplustalfs.

Typic Haplustalfs

Kandiustalfs

Key to subgroups

ICDA. Kandiustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiustalfs

ICDB. Other Kandiustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Kandiustalfs

ICDC. Other Kandiustalfs that have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiustalfs

ICDD. Other Kandiustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Kandiustalfs

ICDE. Other Kandiustalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are moist six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Arenic Aridic Kandiustalfs

ICDF. Other Kandiustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiustalfs

ICDG. Other Kandiustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are moist six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Kandiustalfs

ICDH. Other Kandiustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for 135 or less cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kandiustalfs

ICDI. Other Kandiustalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, and have a value, moist, of 3 or less and have a value, dry, that is no more than one unit higher than the value, moist.

Rhodic Kandiustalfs

ICDJ. Other Kandiustalfs.

Typic Kandiustalfs

Kanhaplustalfs

Key to subgroups

ICEA. Kanhaplustalfs that have a lithic contact within 50 cm of the soil surface.

Lithic Kanhaplustalfs

ICEB. Other Kanhaplustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time when the soil temperature at that depth is 5°C or higher *or* the soil has artificial drainage.

Aquic Kanhaplustalfs

ICEC. Other Kanhaplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are moist less than six-tenths of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Kanhaplustalfs

ICED. Other Kanhaplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for 135 or less cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kanhaplustalfs

ICEE. Other Kanhaplustalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, and have a value moist, of 3 or less and have a value dry that

is no more than one unit higher than the value, moist.
Rhodic Kanhaplustalfs

ICEF. Other Kanhaplustalfs.
Typic Kanhaplustalfs

Natrustalfs

Key to subgroups

ICCA. Natrustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of a natric horizon that is more than 100 cm below the soil surface.
Grossarenic Natrustalfs

ICCB. Other Natrustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface and there is ground water in the mottled horizon at some time of year when the soil temperature is 5°C or higher; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.
Aquic Arenic Natrustalfs

ICCC. Other Natrustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface and there is ground water in the mottled horizon at some time of year when the soil temperature is 5°C or higher.
Aquic Natrustalfs

ICCD. Other Natrustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.
Arenic Natrustalfs

ICCE. Other Natrustalfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the surface.
Petrocalcic Natrustalfs

ICCF. Other Natrustalfs that have a salic horizon that has its upper boundary within 75 cm of the soil surface.
Salorthidic Natrustalfs

ICCG. Other Natrustalfs that have an Ap horizon that has a color value, moist, of 3 or less, or the soil, after mixing to a depth of 18 cm, has a color value, moist, of 3 or less.
Mollic Natrustalfs

ICCH. Other Natrustalfs.

Typic Natrustalfs

Paleustalfs

Key to subgroups

ICFA. Paleustalfs that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for less than four-tenths of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Udertic Paleustalfs

ICFB. Other Paleustalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or

paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Paleustalfs

ICFC. Other Paleustalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Paleustalfs

ICFD. Other Paleustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Paleustalfs

ICFE. Other Paleustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface and the mottled horizon is saturated with water at some time of the year when the temperature of the horizon is $5^{\circ}C$ or higher; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Paleustalfs

ICFF. Other Paleustalfs that have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthic Paleustalfs

ICFG. Other Paleustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when the temperature of the horizon is $5^{\circ}C$ or higher.

Aquic Paleustalfs

ICFH. Other Paleustalfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface.

Petrocalcic Paleustalfs

ICFI. Other Paleustalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. When not irrigated and when not fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Arenic Aridic Paleustalfs

ICFJ. Other Paleustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Paleustalfs

ICFK. Other Paleustalfs that:

1. When not irrigated and when not fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have a calcic horizon within a depth of 100 cm if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, 60 cm if it is loamy, or 50 cm if it is clayey, and they have carbonates in all subhorizons above the calcic horizon.

Calciorthidic Paleustalfs

ICFL. Other Paleustalfs that, when not irrigated and when not fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Paleustalfs

ICFM. Other Paleustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if thicker than 100 cm.

Kandic Paleustalfs

ICFN. Other Paleustalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, and have a value, moist, of 3 or less and have a value, dry, that is no more than one unit higher than the value, moist.

Rhodic Paleustalfs

ICFO. Other Paleustalfs that have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Paleustalfs

ICFP. Other Paleustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for less than four-tenths of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Paleustalfs

ICFQ. Other Paleustalfs.

Typic Paleustalfs

Plinthustalfs

Plinthustalfs are the Ustalfs that have plinthite that forms a continuous phase or that constitutes more than half the matrix of some subhorizon of the argillic horizon within 125 cm of the soil surface. There are no soil series in the United States that are presently classified in this great group, but the group is provided for other parts of the world. Subgroups have not been developed.

Rhodustalfs

Key to subgroups

Because these soils are rare in the United States, the classification that follows probably is incomplete, and it is provisional.

ICGA. Rhodustalfs that have a lithic contact within 50 cm of the soil surface.

Lithic Rhodustalfs

ICGB. Other Rhodustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if the argillic horizon is thicker than 100 cm.

Kanhaplic Rhodustalfs

ICGC. Other Rhodustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Rhodustalfs

ICGD. Other Rhodustalfs.

Typic Rhodustalfs

XERALFS

Key to great groups

IDA. Xeralfs that have a duripan whose upper boundary is within 100 cm of the soil surface but below an argillic or a natric horizon.

Durixeralfs, p. 120

IDB. Other Xeralfs that have a natric horizon.

Natrixeralfs, p. 125

IDC. Other Xeralfs that have a fragipan.

Fragixeralfs, p. 121

IDD. Other Xeralfs that have plinthite that forms a continuous phase in, or constitutes more than half the matrix of, some subhorizon of the argillic horizon within 150 cm of the soil surface.

Plinthoxeralfs, p. 127

IDE. Other Xeralfs that have an argillic horizon that, in all parts, has a color hue redder than 5YR and a value, moist, 3 or less and a value, dry, no more than one unit higher than the value, moist.

Rhodoxeralfs, p. 127

IDF. Other Xeralfs that have *either*:

1. A petrocalcic horizon whose upper boundary is within 150 cm of the soil surface; *or*

2. Do *not* have a lithic or paralithic contact within 150 cm of the soil surface; and the argillic horizon

   a. Has a vertical clay distribution such that the percentage of clay does not decrease from the maximum by as much as 20 percent throughout a depth of 150 cm from the soil surface, or the horizon in which the clay decreases either has greater than 5 percent plinthite by volume or has skeletans or other evidences of clay eluviation; *and*

   b. Has *one or both* of the following:

      (1) A hue redder than 10YR and chroma, moist or dry, of more than 4 in the matrix of at least the lower part of the argillic horizon; *or*

      (2) Common coarse mottles that have a hue of 7.5YR or redder or chroma, moist or dry, greater than 5, or both, in at least the lower part of the argillic horizon; *or*

3. Have an argillic horizon that has a clayey particle-size class in the upper part and an increase of at least 20 percent clay (absolute) within a vertical distance of 7.5 cm or of at least 15 percent clay (absolute) within a vertical distance of 2.5 cm at the upper boundary; and there is no lithic or paralithic contact within 50 cm of the surface of the soil.

Palexeralfs, p. 125

IDG. Other Xeralfs.

Haploxeralfs, p. 122

Durixeralfs

Key to subgroups

IDAA. Durixeralfs that have a natric horizon.

Natric Durixeralfs

IDAB. Other Durixeralfs that have mottles in the argillic horizon that have chroma of 2 or less.

Aquic Durixeralfs

IDAC. Other Durixeralfs that:

1. Have an argillic horizon that:

a. Has 35 percent or more clay in some subhorizon at least 7.5 cm thick; *and*

b. Has an increase in clay content that is 15 percent or more (absolute) within a vertical distance of 2.5 cm, or is 20 percent or more (absolute) within a vertical distance of 7.5 cm, at the upper boundary or within some part; *and*

2. Have a duripan that is *not* both massive, platy, or prismatic and more than half of its upper boundary indurated and coated with opal or with opal and sesquioxides, or indurated in some subhorizon below the upper boundary.

Abruptic Haplic Durixeralfs

IDAD. Other Durixeralfs that have an argillic horizon that:

1. Has 35 percent or more clay in some subhorizon at least 7.5 cm thick; *and*

2. Has an increase in clay content that is 15 percent or more (absolute) within a vertical distance of 2.5 cm, or is 20 percent or more (absolute) within a vertical distance of 7.5 cm, at the upper boundary or within some part.

Abruptic Durixeralfs

IDAE. Other Durixeralfs that have a duripan that is *not* both massive, platy, or prismatic and more than half of its upper boundary indurated and coated with opal or with opal and sesquioxides, or indurated in some subhorizon below the upper boundary.

Haplic Durixeralfs

IDAF. Other Durixeralfs.

Typic Durixeralfs

Fragixeralfs

Key to subgroups

IDCA. Fragixeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragixeralfs

IDCB. Other Fragixeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragixeralfs

IDCC. Other Fragixeralfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil to a depth of 18 cm, after mixing, has those colors.

Mollic Fragixeralfs

IDCD. Other Fragixeralfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of the year when the soil temperature is 5°C or higher in those horizons. Mottles are not the same as skeletans that may also have low chroma.

Aquic Fragixeralfs

IDCE. Other Fragixeralfs that do *not* have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds, or both.

Ochreptic Fragixeralfs

IDCF. Other Fragixeralfs.

Typic Fragixeralfs

Haploxeralfs

Key to subgroups

IDGA. Haploxeralfs that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an A horizon that throughout its upper 10 cm has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon, or have an Ap horizon that has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon.

Lithic Mollic Haploxeralfs

IDGB. Other Haploxeralfs that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon that is discontinuous horizontally throughout the area of each pedon.

Lithic Ruptic-Xerochreptic Haploxeralfs

IDGC. Other Haploxeralfs that have a lithic contact within 50 cm of the soil surface.

Lithic Haploxeralfs

IDGD. Other Haploxeralfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haploxeralfs

IDGE. Other Haploxeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploxeralfs

IDGF. Other Haploxeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haploxeralfs

IDGG. Other Haploxeralfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface and the mottled horizon is saturated with water at some time when the temperature of that horizon is 5°C or higher or there is artificial drainage; *and*

2. Have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent in one or more subhorizons of the upper 75 cm or to a lithic or paralithic contact, whichever is shallower.

Aquultic Haploxeralfs

IDGH. Other Haploxeralfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface and the mottled horizon is saturated with water at some time when the temperature of that horizon is 5°C or higher or there is artificial drainage.

Aquic Haploxeralfs

IDGI. Other Haploxeralfs that have exchangeable sodium that is 15 percent or more of the CEC (at pH 8.2) in one or more subhorizons in the argillic horizon.

Natric Haploxeralfs

IDGJ. Other Haploxeralfs that have an argillic horizon that is discontinuous vertically within the upper 20 cm or has a sandy particle-size class.

Psammentic Haploxeralfs

IDGK. Other Haploxeralfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Haploxeralfs

IDGL. Other Haploxeralfs that have a calcic horizon that has its upper boundary within the upper 100 cm of soil.

Calcic Haploxeralfs

IDGM. Other Haploxeralfs that have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent in one or more subhorizons of the upper 75 cm or to a lithic or paralithic contact, whichever is shallower.

Ultic Haploxeralfs

IDGN. Other Haploxeralfs that have an A horizon that has throughout its upper 10 cm a color value, moist, of 3 or less and 0.7 percent or more organic carbon, or have an Ap horizon that has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon.

Mollic Haploxeralfs

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Palexeralfs

IDFD. Other Palexeralfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is 5°C or higher or there is artificial drainage.

Aquic Palexeralfs

IDFE. Other Palexeralfs that have a petrocalcic horizon whose upper boundary is within 150 cm of the soil surface.

Petrocalcic Palexeralfs

IDFF. Other Palexeralfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Palexeralfs

IDFG. Other Palexeralfs that have 15 percent or more saturation with sodium in one or more subhorizons within 100 cm of the soil surface.

Natric Palexeralfs

IDFH. Other Palexeralfs that have a calcic horizon within 150 cm of the soil surface.

Calcic Palexeralfs

IDFI. Other Palexeralfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Palexeralfs

IDFJ. Other Palexeralfs that have an argillic horizon that has less than 75 percent base saturation (by sum of cations) throughout.

Ultic Palexeralfs

IDFK. Other Palexeralfs that have an argillic horizon in which the upper part does not have a clayey particle-size class, or there is an increase of less than 20 percent clay (absolute) within a vertical distance of 7.5 cm or less than 15 percent clay (absolute) within 2.5 cm at the upper boundary.

Haplic Palexeralfs

IDFL. Other Palexeralfs that have an A horizon that, throughout its upper 10 cm, has a color value, moist, of 3 or

upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitrands, p. 153

BF. Other Andisols that have an ustic soil moisture regime.

Ustands, p.150

BG. Other Andisols.

Udands, p. 139

AQUANDS

Key to great groups

BAA. Aquands that have a cryic or pergelic soil temperature regime.

Cryaquands, p.130

BAB. Other Aquands that have a placic horizon within 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower, in half or more of each pedon.

Placaquands, p. 133

BAC. Other Aquands that have a cemented layer in 75 percent or more of each pedon which does not slake in water after drying, with its upper boundary within 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower.

Duraquands, p. 131

BAD. Other Aquands that have 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples, throughout a thickness of 35 cm or more within 60 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitraquands, p. 133

BAE. Other Aquands that have a melanic epipedon.

Melanaquands, p.132

BAF. Other Aquands.

Haplaquands, p. 131

Cryaquands

Key to subgroups

BAAA. Cryaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Cryaquands

BAAB. Other Cryaquands that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryaquands

BAAC. Other Cryaquands that have a histic epipedon.

Histic Cryaquands

BAAD. Other Cryaquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Cryaquands

BAAE. Other Cryaquands.

Typic Cryaquands

Duraquands

Key to subgroups

BACA. Duraquands that have a histic epipedon.

Histic Duraquands

BACB. Other Duraquands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acraquoxic Duraquands

BACC. Other Duraquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Duraquands

BACD. Other Duraquands.

Typic Duraquands

Haplaquands

Key to subgroups

BAFA. Haplaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Haplaquands

BAFB. Other Haplaquands that have a petroferric contact within 100 cm of the soil surface.

Petroferric Haplaquands

BAFC. Other Haplaquands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Haplaquands

BAFD. Other Haplaquands that have a histic epipedon.

Histic Haplaquands

Placaquands

Key to subgroups

BABA. Placaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Placaquands

BABB. Other Placaquands that have a histic epipedon, and have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Histic Placaquands

BABC. Other Placaquands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Placaquands

BABD. Other Placaquands that have a histic epipedon.

Histic Placaquands

BABE. Other Placaquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Placaquands

BABF. Other Placaquands.

Typic Placaquands

Vitraquands

Key to subgroups

BADA. Vitraquands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitraquands

BADB. Other Vitraquands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Vitraquands

BADC. Other Vitraquands that have a histic epipedon.

Histic Vitraquands

or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Haplocryands

BBFG. Other Haplocryands that have a xeric soil moisture regime.

Xeric Haplocryands

BBFH. Other Haplocryands that have a spodic horizon, and an associated eluvial horizon with its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Spodic Haplocryands

BBFI. Other Haplocryands.

Typic Haplocryands

Hydrocryands

Key to subgroups

BBDA. Hydrocryands that have a lithic contact within 50 cm of the soil surface.

Lithic Hydrocryands

BBDB. Other Hydrocryands that have a placic horizon within 100 cm of the soil surface.

Placic Hydrocryands

BBDC. Other Hydrocryands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Hydrocryands

BBDD. Other Hydrocryands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Hydrocryands

BBDE. Other Hydrocryands.

Typic Hydrocryands

BBEE. Other Vitricryands that have a spodic horizon, and an associated eluvial horizon with its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Spodic Vitricryands

BBEF. Other Vitricryands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Alfic Vitricryands

BBEG. Other Vitricryands.

Typic Vitricryands

TORRANDS

Key to great groups

BCA. All Torrands are regarded as Vitritorrands.

Vitritorrands, p. 138

Vitritorrands

Key to subgroups

BCAA. Vitritorrands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitritorrands

BCAB. Other Vitritorrands that have a petrocalcic horizon with its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Vitritorrands

BCAC. Other Vitritorrands that have a horizon with its upper boundary within 100 cm of a mineral soil surface which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Vitritorrands

BCAD. Other Vitritorrands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year.

Aquic Vitritorrands

BCAE. Other Vitritorrands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Vitritorrands

BGBC. Other Durudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6.0 percent organic carbon and colors of a mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Durudands

BGBD. Other Durudands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Durudands

BGBE. Other Durudands.

Typic Durudands

Fulvudands

Key to subgroups

BGDA. Fulvudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more, and have a lithic contact within 50 cm of the soil surface.

Hydric Lithic Fulvudands

BGDB. Other Fulvudands that have a lithic contact within 50 cm of the soil surface.

Lithic Fulvudands

BGDC. Other Fulvudands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Fulvudands

BGDD. Other Fulvudands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of ped, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Fulvudands

BGDE. Other Fulvudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, undried, kPa water retention of 70

BGDM. Other Fulvudands that have, between 40 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Fulvudands

BGDN. Other Fulvudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Fulvudands

BGDO. Other Fulvudands.

Typic Fulvudands

Hapludands

Key to subgroups

BGFA. Hapludands that have a lithic contact within 50 cm of the soil surface.

Lithic Hapludands

BGFB. Other Hapludands that have a petroferric contact within 100 cm of the soil surface.

Petroferric Hapludands

BGFC. Other Hapludands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying, and have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Duric Hapludands

BGFD. Other Hapludands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Hapludands

kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Pachic Vitric Melanudands

BGCK. Other Melanudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Vitric Melanudands

BGCL. Other Hapludands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanudands

BGCM. Other Melanudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Melanudands

BGCN. Other Melanudands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Melanudands

BGCO. Other Melanudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Hydric Melanudands

BGCP. Other Melanudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Hydric Melanudands

BGCQ. Other Melanudands that have, between 40 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Melanudands

BGCR. Other Melanudands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Ultic Melanudands

BGCS. Other Melanudands.

Typic Melanudands

Placudands

Key to subgroups

BGAA. Placudands that have a lithic contact within 50 cm of the soil surface.

Lithic Placudands

BGAB. Other Placudands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Placudands

BGAC. Other Placudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Placudands

BGAD. Other Placudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Placudands

BGAE. Other Placudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick

BFB. Other Ustands.

Haplustands, p. 151

Durustands

Key to subgroups

BFAA. Durustands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Durustands

BFAB. Other Durustands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Durustands

BFAC. Other Durustands that have a mollic epipedon.

Mollic Durustands

BFAD. Other Durustands that have an umbric epipedon.

Umbric Durustands

BFAE. Other Durustands.

Typic Durustands

Haplustands

Key to subgroups

BFBA. Haplustands that have a lithic contact within 50 cm of the soil surface.

Lithic Haplustands

BFBB. Other Haplustands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Haplustands

BFBC. Other Haplustands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 15.0 cmol(+) kg^{-1} in

VITRANDS

Key to great groups

BEA. Vitrands that have an ustic soil moisture regime.
Ustivitrands, p. 153

BEB. Other Vitrands.
Udivitrands, p. 153

Udivitrands

Key to subgroups

BEBA. Udivitrands that have a lithic contact within 50 cm of the soil surface.
Lithic Udivitrands

BEBB. Other Udivitrands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Udivitrands

BEBC. Other Udivitrands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.
Thaptic Udivitrands

BEBD. Other Udivitrands that have a spodic horizon, and an associated eluvial horizon with its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.
Spodic Udivitrands

BEBE. Other Udivitrands.
Typic Udivitrands

Ustivitrands

Key to subgroups

BEAA. Ustivitrands that have a lithic contact within 50 cm of the soil surface.
Lithic Ustivitrands

BEAB. Other Ustivitrands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Ustivitrands

BEAC. Other Ustivitrands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Ustivitrands

BEAD. Other Ustivitrands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Ustivitrands

BEAE. Other Ustivitrands that have a mollic epipedon.

Mollic Ustivitrands

BEAF. Other Ustivitrands that have an umbric epipedon.

Umbric Ustivitrands

BEAG. Other Ustivitrands.

Typic Ustivitrands

XERANDS

Key to great groups

BDA. Xerands that have 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples, throughout a thickness of 35 cm or more within 60 cm of the mineral soil surface.

Vitrixerands, p. 156

BDB. Other Xerands that have a melanic epipedon.

Melanoxerands, p. 156

BDC. Other Xerands.

Haploxerands, p. 154

Haploxerands

Key to subgroups

BDCA. Haploxerands that have a lithic contact within 50 cm of the soil surface.

Lithic Haploxerands

BDCB. Other Haploxerands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Haploxerands

BDCC. Other Haploxerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface, and base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface.

Ultic Vitric Haploxerands

BDCD. Other Haploxerands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface.

Vitric Haploxerands

BDCE. Other Haploxerands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Haploxerands

BDCF. Other Haploxerands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Haploxerands

BDCG. Other Haploxerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, and base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon.

Ultic Haploxerands

BDCH. Other Haploxerands that have

1. A mollic epipedon; *and*

2. An argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Argixerollic Haploxerands

BDCI. Other Haploxerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Alfic Haploxerands

BDCJ. Other Haploxerands that have a mollic epipedon.

Mollic Haploxerands

BDCK. Other Haploxerands that have an umbric epipedon.

Umbric Haploxerands

BDCL. Other Haploxerands.

Typic Haploxerands

Melanoxerands

Key to subgroups

BDBA. Melanoxerands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Melanoxerands

BDBB. Other Melanoxerands.

Typic Melanoxerands

Vitrixerands

Key to subgroups

BDAA. Vitrixerands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitrixerands

BDAB. Other Vitrixerands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Vitrixerands

BDAC. Other Vitrixerands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Vitrixerands

BDAD. Other Vitrixerands that have a spodic horizon, and an associated eluvial horizon with its upper boundary within 125 cm of the mineral soil surface.

Spodic Vitrixerands

BDAE. Other Vitrixerands that have

1. A mollic epipedon; *and*

2. An argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Argixerollic Vitrixerands

BDAF. Other Vitrixerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Alfic Vitrixerands

BDAG. Other Vitrixerands that have a mollic epipedon.

Mollic Vitrixerands

BDAH. Other Vitrixerands that have an umbric epipedon.

Umbric Vitrixerands

BDAI. Other Vitrixerands.

Typic Vitrixerands

Chapter 7

Aridisols

KEY TO SUBORDERS

FA. Aridisols that have an argillic or a natric horizon.
Argids, p. 159

FB. Other Aridisols.
Orthids, p. 178

ARGIDS

Key to great groups

FAA. Argids that have a duripan[1] below an argillic horizon and do not have a natric horizon.
Durargids, p.159

FAB. Other Argids that have a duripan below a natric horizon.
Nadurargids, p. 169

FAC. Other Argids that have a natric horizon and do not have a petrocalcic horizon.
Natrargids, p. 170

FAD. Other Argids that do not have a lithic or paralithic contact within 50 cm of the soil surface, that have a petrocalcic horizon or that have an argillic horizon that has 35 percent or more clay in some part, and that have *either*:

1. An increase of 15 percent or more clay (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon; *or*

2. An increase of 10 percent or more clay (absolute) if cultivated and the lower boundary of the Ap horizon is the upper boundary of the argillic horizon.
Paleargids, p. 174

FAE. Other Argids.
Haplargids, p. 163

Durargids

Key to subgroups

FAAA. Durargids that are saturated with water within 100 cm of the surface for 90 consecutive days or more in most years, *or* have any of the following characteristics within 100 cm of the soil surface if there is ground water within this depth at some time in most years:

---

[1] A duripan or a petrocalcic horizon must have its upper boundary within 100 cm of the surface to be diagnostic in Aridisols.

1. Dominant chroma of 1 or less throughout the horizons and hue as yellow or yellower than 2.5Y in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable sodium) in more than half the thickness of the horizon between the surface and 50 cm depth than in the saturated zone.

Aquic Durargids

FAAB. Other Durargids that have the following combination of characteristics:

1. A duripan at a depth 18 cm or more; *and*

2. The weighted average percentage of organic carbon in the upper soil to a depth of 40 cm is 0.6 or more if the weighted average ratio of sand to clay in the upper soil to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay in the upper soil is more than 1.0 but less than 13; and the weighted average percentage of organic carbon in the upper soil to a depth of 18 cm is one-fifth or more higher than the values just stated if a duripan is present at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime; *and*

4. An argillic horizon that has 35 percent or more clay in some part and also has *either*:

a. An increase of 15 percent or more clay (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon; *or*

b. An increase of 10 percent or more clay (absolute) if cultivated and the lower boundary of the Ap horizon is the upper boundary of the argillic horizon.

Abruptic Xerollic Durargids

FAAC. Other Durargids that have an argillic horizon that has 35 percent or more clay in some part, and also have *either*:

1. An increase of 15 percent or more clay (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon; *or*

2. An increase of 10 percent or more clay (absolute) if cultivated and the lower boundary of the Ap horizon is the upper boundary of the argillic horizon.

Abruptic Durargids

Haplargids

Key to subgroups

FAEA. Haplargids that have the following combination of characteristics:

1. A frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. A lithic contact within 50 cm of the surface; *and*

3. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Lithic Haplargids

FAEB. Other Haplargids that have the following combination of characteristics:

1. A lithic contact within 50 cm of the surface; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. An argillic horizon that is not continuous throughout the area of each pedon; *and*

4. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Ruptic-Entic Xerollic Haplargids

FAEC. Other Haplargids that have the following combination of characteristics:

1. A lithic contact within 50 cm of the surface; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or

more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Haplargids

FAED. Other Haplargids that have the following combination of characteristics:

1. A lithic contact within 50 cm of the surface; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Lithic Ustollic Haplargids

FAEE. Other Haplargids that have a lithic contact within 50 cm of the surface.

Lithic Haplargids

FAEF. Other Haplargids that have the following combination of characteristics:

1. A frigid or colder temperature regime; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; *and*

3. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface, to the base of an Ap horizon, or to the top of the argillic horizon, and the cracks are not closed for as many as 60 consecutive days of the 120 days following the winter solstice in 3 or more years out of 10; *and*

argillic horizon, and the cracks remain open from 175 to 240 days, cumulative, in most years; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Ustertic Haplargids

FAEJ. Other Haplargids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface, to the base of an Ap horizon, or to the top of the argillic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplargids

FAEK. Other Haplargids that are saturated with water for 90 consecutive days or more within 100 cm of the surface in most years or have any of the following characteristics within a depth of 100 cm below the surface if there is ground water within this depth at some time in most years:

1. Dominant chroma of 1 or less throughout and a hue 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone.

Aquic Haplargids

FAEL. Other Haplargids that have the following combination of characteristics:

1. A texture that is loamy fine sand or coarser in all subhorizons above a depth of 50 cm; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate

between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Arenic Ustollic Haplargids

FAEM. Other Haplargids that have the following combination of characteristics:

1. A texture that is loamy fine sand or coarser in all subhorizons above a depth of 50 cm; *and*

2. Dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Arenic Ustalfic Haplargids

FAEN. Other Haplargids that have a texture that is loamy fine sand or coarser in all subhorizons above a depth of 50 cm.

Arenic Haplargids

FAEO. Other Haplargids that have the following combination of characteristics:

1. A horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more (by volume) durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Haplargids

FAEP. Other Haplargids that have a horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more (by volume) durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist.

Duric Haplargids

FAEQ. Other Haplargids that have:

1. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Haplargids

FAER. Other Haplargids that are:

1. Dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xeralfic Haplargids

FAES. Other Haplargids that have:

1. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustollic Haplargids

FAET. Other Haplargids that are:

1. Dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

2. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustalfic Haplargids

FAEU. Other Haplargids.

Typic Haplargids

Nadurargids

Key to subgroups

FABA. Nadurargids that:

1. Are saturated with water in some horizon within a depth of 100 cm at some time and have *either* of the following characteristics within the horizon or horizons that are saturated:

a. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

b. Both a dominant chroma of 2 or less and mottles that are not due to segregated lime; *and*

2. Do not have a platy or massive duripan that is indurated in some subhorizon.

Aquic Haplic Nadurargids

FABB. Other Nadurargids that are saturated with water in some horizon within a depth of 100 cm at some time and have *either* of the following characteristics within the horizon or horizons that are saturated:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Both a dominant chroma of 2 or less and mottles that are not due to segregated lime.

Aquic Nadurargids

FABC. Other Nadurargids that have the following combination of characteristics:

1. Do not have a duripan that is indurated in some subhorizon; *and*

2. A duripan 18 cm or deeper; *and*

3. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to clay to that depth is 1.0 or less, or that is one-seventh percent or more if the ratio of sand to clay is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a duripan that is shallower than 40 cm but deeper than 18 cm; *and*

4. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Haploxerollic Nadurargids

FABD. Other Nadurargids that do not have a platy or massive duripan that is indurated in some subhorizon.

Haplic Nadurargids

FABE. Other Nadurargids that have:

1. A duripan 18 cm or deeper; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to clay to that depth is 1.0 or less, or that is one-seventh percent or more if the ratio of sand to clay is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a duripan that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Nadurargids

FABF. Other Nadurargids.

Typic Nadurargids

Natrargids

Key to subgroups

FACA. Natrargids that have the following combination of characteristics:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an

1. A horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Natrargids

FACG. Other Natrargids that have a horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist.

Duric Natrargids

FACH. Other Natrargids that have the following combination of characteristics:

1. More than 10 percent of the ped surfaces deeper than 2.5 cm below the upper boundary of the natric horizon covered by skeletans; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. An aridic moisture regime that borders on ustic.

Glossic Ustollic Natrargids

FACI. Other Natrargids that have the following combination of characteristics:

1. An SAR of less than 13 or less than 15 percent saturation with sodium throughout the major part of the natric horizon; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13

or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on ustic.
Haplustollic Natrargids

FACJ. Other Natrargids that have the following combination of characteristics:

1. An SAR of less than 13 or less than 15 percent saturation with sodium throughout the major part of the natric horizon; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on xeric.
Haploxerollic Natrargids

FACK. Other Natrargids that have an SAR of less than 13 or less than 15 percent saturation with sodium throughout the major part of the natric horizon.
Haplic Natrargids

FACL. Other Natrargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

2. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on xeric.
Xerollic Natrargids

4. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

5. A frigid or colder soil temperature regime.

Borollic Vertic Paleargids

FADB. Other Paleargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. A frigid or colder soil temperature regime and an aridic moisture regime that borders on an ustic regime.

Borollic Paleargids

FADC. Other Paleargids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface, to the base of an Ap horizon, or to the top of the argillic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Paleargids

FADD. Other Paleargids that have the following combination of characteristics:

1. A petrocalcic horizon whose upper boundary is within 100 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Petrocalcic Xerollic Paleargids

FADE. Other Paleargids that have the following combination of characteristics:

1. A petrocalcic horizon whose upper boundary is within 100 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature that is 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Petrocalcic Ustollic Paleargids

FADF. Other Paleargids that:

1. Have a petrocalcic horizon whose upper boundary is within 100 cm of the soil surface; *and*

2. Are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

3. Have a mean annual soil temperature that is 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Petrocalcic Ustalfic Paleargids

FADG. Other Paleargids that have a petrocalcic horizon whose upper boundary is within 100 cm of the soil surface.

Petrocalcic Paleargids

FADH. Other Paleargids that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Duric Paleargids

FADI. Other Paleargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of

organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Paleargids

FADJ. Other Paleargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustollic Paleargids

FADK. Other Paleargids that:

1. Are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more; and an aridic moisture regime that borders on a xeric regime.

Xeralfic Paleargids

FADL. Other Paleargids that:

1. Are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

2. A mean annual soil temperature that is 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustalfic Paleargids

FADM. Other Paleargids.

Typic Paleargids

clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Calciorthids

FBEI. Other Calciorthids that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Duric Calciorthids

FBEJ. Other Calciorthids that have the following combination of characteristics:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Calciorthids

FBEK. Other Calciorthids that have the following combination of characteristics:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Calciorthids

FBEL. Other Calciorthids that are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm, and have a mean annual soil

if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

4. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Lithic Camborthids

FBFC. Other Camborthids that have the following combination of characteristics:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Camborthids

FBFD. Other Camborthids that have a lithic contact within 50 cm of the surface.

Lithic Camborthids

FBFE. Other Camborthids that have an SAR of more than 45, or 40 percent or more saturation with sodium, throughout the cambic horizon, and the saturated hydraulic conductivity is slow or very slow.

Natric Camborthids

FBFF. Other Camborthids that have the following combination of characteristics:

1. Have a frigid or colder temperature regime; *and*

2. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon, and the cracks are not closed for as many as 60 consecutive days of the 120 days following the winter solstice in 3 or more years out of 10; *and*

3. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

4. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

5. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13.

Borollic Vertic Camborthids

FBFG. Other Camborthids that have the following combination of characteristics:

1. Have a frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Camborthids

FBFH. Other Camborthids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

4. Have a thermic, mesic, or frigid soil temperature regime and have cracks that are closed for 60 consecutive days or more during the 120 days following the winter solstice in more than 7 years out of 10.

Xerertic Camborthids

FBFQ. Other Camborthids that have a content of organic carbon that decreases irregularly with depth below a depth of 25 cm or, unless a lithic or paralithic contact occurs at a shallower depth, has a level of 0.2 percent or more at a depth 125 cm below the surface.

Fluventic Camborthids

FBFR. Other Camborthids that:

1. Have an anthropic epipedon; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm.

Anthropic Camborthids

FBFS. Other Camborthids that:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Camborthids

FBFT. Other Camborthids that:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Camborthids

FBFU. Other Camborthids that are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or more at a depth of 50 cm unless the soil is irrigated, and have an aridic moisture regime that borders on a xeric moisture regime.

Xerochreptic Camborthids

FBFV. Other Camborthids that are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or more at a depth of 50 cm unless the soil is irrigated, and have an aridic moisture regime that borders on an ustic moisture regime and a hyperthermic, thermic, or mesic soil temperature regime.

Ustochreptic Camborthids

FBFW. Other Camborthids.

Typic Camborthids

Durorthids

Key to subgroups

FBCA. Durorthids that have the following combination of characteristics:

1. Are saturated with water for 90 consecutive days or more in most years within 100 cm of the surface, or have one or more subhorizons within 100 cm of the soil surface with any of the following characteristics if the horizon is saturated with water at some period in most years, or the soil is artificially drained:

   a. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

   b. Dominant chroma of 2 or less accompanied by mottles that are not due to segregated lime; *or*

   c. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable sodium) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone; *and*

2. Have a duripan that is not indurated in any subhorizon.

Aquentic Durorthids

FBCB. Other Durorthids that are saturated with water for 90 consecutive days or more in most years within 100 cm of the surface, or have one or more subhorizons within 100 cm of the soil surface with any of the following characteristics if the horizon is saturated with water at some period in most years, or the soil is artificially drained:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less accompanied by mottles that are not due to segregated lime; *or*

1. Have a duripan that is not indurated in any subhorizon; *and*

2. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Haploxerollic Durorthids

FBCF. Other Durorthids that have the following combination of characteristics:

1. Have a duripan that is not indurated in any subhorizon; *and*

2. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

3. Have an aridic moisture regime that borders on an ustic regime.

Haplustollic Durorthids

FBCG. Other Durorthids that have the following combination of characteristics:

1. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Xerollic Durorthids

FBCH. Other Durorthids that are dry in all parts of the moisture control section for three-fourths or less of the time that the soil temperature at a depth of 50 cm is 5°C or higher, and have an aridic moisture regime that borders on a xeric regime.

Xerochreptic Durorthids

FBCI. Other Durorthids that have the following combination of characteristics:

1. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Durorthids

FBCJ. Other Durorthids that are dry in all parts of the moisture control section for three-fourths or less of the time that the soil temperature at a depth of 50 cm is 5°C or higher.

Ustochreptic Durorthids

FBCK. Other Durorthids that have a duripan that is not indurated in any subhorizon.

Entic Durorthids

FBCL. Other Durorthids.

Typic Durorthids

Gypsiorthids

Key to subgroups

FBDA. Gypsiorthids that have a petrogypsic horizon whose upper boundary is within 100 cm of the soil surface.

Petrogypsic Gypsiorthids

FBDB. Other Gypsiorthids that have a gypsic horizon in which the product of the percentage of gypsum and the thickness in centimeters above a depth of 150 cm is less than 3,000, and have a calcic horizon above the gypsic horizon.

Calcic Gypsiorthids

FBDC. Other Gypsiorthids that have a gypsic horizon in which the product of the percentage of gypsum and the thickness in centimeters above a depth of 150 cm is less than 3,000.

Cambic Gypsiorthids

FBDD. Other Gypsiorthids.

Typic Gypsiorthids

Paleorthids

Key to subgroups

FBBA. Paleorthids that:

1. Have a petrocalcic horizon whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm

that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; and have a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon that is shallower than 40 cm but deeper than 18 cm; *and*

2. Have a frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime.

Borollic Paleorthids

FBBB. Other Paleorthids that are saturated with water for 90 consecutive days or more in most years within 100 cm below the soil surface, or have one or more subhorizons with any of the following characteristics within 100 cm of the surface if the horizon is saturated with water at some period in most years, or the soil is artificially drained:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone.

Aquic Paleorthids

FBBC. Other Paleorthids that:

1. Have a petrocalcic horizon whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; and have a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon that is shallower than 40 cm but deeper than 18 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Xerollic Paleorthids

FBBD. Other Paleorthids that:

1. Have a petrocalcic horizon whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less,

Chapter 8

Entisols

KEY TO SUBORDERS

KA. Entisols that

1. Have sulfidic materials within 50 cm of the mineral soil surface; *or*

2. Are permanently saturated with water and have in all horizons below 25 cm

a. Dominant hue that is neutral or bluer than 10Y; *and*

b. Colors that change on exposure to the air; *or*

3. Are saturated with water at some time of year or are artificially drained and have, within 50 cm of the surface, dominant color (moist) in the matrix as follows:

a. In horizons that have texture finer than loamy fine sand in some or all subhorizons, or that have more than 35 percent (by volume) of rock fragments in some subhorizon:

(1) If there is mottling, chroma is 2 or less; *or*

(2) If there is no mottling and the value is less than 4, chroma is less than 1; if the value is 4 or more, chroma is 1 or less; *or*

b. In horizons that have texture of loamy fine sand or coarser in all subhorizons:

(1) If the hue is as red or redder than 10YR and there is mottling, chroma is 2 or less; if there is no mottling and the value is less than 4, chroma is less than 1; or if the value is 4 or more, chroma is 1 or less; *or*

(2) If the hue is between 10YR and 10Y and there is distinct or prominent mottling, chroma is 3 or less; if there is no mottling, chroma is 1 or less; *or*

(3) Hue is bluer than 10Y; *or*

(4) Any color if the color is due to uncoated grains of sand.

Aquents, p. 196

KB. Other Entisols that have 3 percent or more, by volume, fragments of diagnostic horizons in one or more subhorizons between 25 and 100 cm below the soil surface, and the fragments are not arranged in discernible order.

Arents, p. 202

KC. Other Entisols that have below the Ap horizon or below a depth of 25 cm, whichever is deeper, less than 35 percent (by volume) of rock fragments and that have texture of loamy fine sand or coarser in all subhorizons[1] either to a depth of 100 cm or to a lithic, paralithic, or petroferric contact, whichever is shallower.

Psamments, p. 217

KD. Other Entisols that do not have a lithic or paralithic contact within 25 cm of the soil surface and that have slopes of less than 25 percent and organic-carbon content that decreases irregularly with depth or remains above a level of 0.2 percent to a depth of 125 cm, and the mean annual soil temperature is higher than 0°C. (Strata of sand or loamy sand may have less organic carbon if finer sediments at a depth of 125 cm or below have 0.2 percent organic carbon or more).

Fluvents, p. 203

KE. Other Entisols.

Orthents, p. 209

AQUENTS

Key to great groups

KAA. Aquents that have sulfidic materials within 50 cm of the mineral soil surface.

Sulfaquents, p. 202

KAB. Other Aquents that have an *n* value of more than 0.7 and that have at least 8 percent clay in all subhorizons between a depth of 20 and 50 cm and that have a mean annual soil temperature higher than 0°C.

Hydraquents, p. 201

KAC. Other Aquents that have a cryic but not a pergelic[2] soil temperature regime.

Cryaquents, p. 197

KAD. Other Aquents that have an organic-carbon content[3] that decreases irregularly with depth or that remains above 0.2 percent to a depth of 125 cm; and that have texture finer than loamy fine sand in some or all subhorizons between the Ap horizon or a depth of 25 cm, whichever is deeper, and 100 cm or a lithic or paralithic contact, whichever is shallower. Thin strata of sand may have less organic carbon if the finer sediments at a depth of 125 cm or below have 0.2 percent organic carbon or more.

Fluvaquents, p. 197

---

[1] Lamellae that are less than 1 cm thick or that are too few to meet the requirements for an argillic horizon are permitted to have texture of sandy loam. See the definition of an argillic horizon (Ch. 1).

[2] Soils that otherwise could be Aquents are grouped with Aquepts if there is permafrost.

[3] The carbon should be of Holocene age. It is *not* the intent to include fossil carbon from transported fragments of bedrock or from buried Pleistocene deposits. The mean residence time of the carbon should be less than 11,000 years B.P.

long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. The cracks are not open permanently; *and*

3. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

4. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Fluvaquents

KADC. Other Fluvaquents that:

1. Have a buried Histosol or a buried histic epipedon that has its upper boundary within 100 cm of the soil surface; *and*

2. Have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Thapto-Histic Tropic Fluvaquents

KADD. Other Fluvaquents that have a buried Histosol or a buried histic epipedon that has its upper boundary within 100 cm of the soil surface.

Thapto-Histic Fluvaquents

KADE. Other Fluvaquents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Fluvaquents

KADF. Other Fluvaquents that:

1. Have in more than 40 percent of the matrix in one or more subhorizons between the Ap horizon or a depth of

25 cm, whichever is deeper, and a depth of 75 cm, *one or more* of the following:

a. If mottled and

(1) If the hue is 2.5Y or redder[4] and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

(2) If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

(3) If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

b. The chroma, moist, is 2 or more and there are no mottles; *and*

2. Have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Aeric Tropic Fluvaquents

KADG. Other Fluvaquents that have in more than 40 percent of the matrix in one or more subhorizons between the Ap horizon or a depth of 25 cm, whichever is deeper, and a depth of 75 cm, *one or more* of the following:

1. If mottled and

a. If the hue is 2.5Y or redder[5] and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

c. If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

2. The chroma, moist, is 2 or more and there are no mottles.

Aeric Fluvaquents

KADH. Other Fluvaquents that have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Tropic Fluvaquents

---

4 If the hue of the matrix is 7.5YR or redder and if peds are present, ped exteriors have dominant chroma, moist, of 1 or less, and ped interiors have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, is 1 or less immediately below any surface horizon that has value, moist, of 3 or less.

5 If the hue of the matrix is 7.5YR or redder and if peds are present, ped exteriors have dominant chroma, moist, of 1 or less, and ped interiors have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, is 1 or less immediately below any surface horizon that has value, moist, of 3 or less.

Sulfaquents

Key to subgroups

KAAA. Sulfaquents that have sulfidic materials at a depth *of 30 cm or more* and an *n* value of less than 1.
Haplic Sulfaquents

KAAB. Other Sulfaquents.
Typic Sulfaquents

Tropaquents

The definition of the great group of Tropaquents that follows cannot be tested in the United States and is provisional.

Tropaquents are the Aquents that

1. Have an isomesic or warmer *iso* temperature regime; *and*

2. Have an *n* value of 0.7 or less or have less than 8 percent clay in some subhorizon between 20 and 50 cm; *and*

3. Have an organic-carbon content[7] that decreases regularly with depth below 25 cm and reaches a level of 0.2 percent or less within a *depth of* 125 *cm*.

Subgroups have not been defined.

ARENTS

Key to great groups

KBA. Arents that have an ustic soil moisture regime.
Ustarents, p. 203

KBB. Other Arents that have a xeric soil moisture regime.
Xerarents, p. 203

KBC. Other Arents that have a torric soil moisture regime.
Torriarents, p. 202

KBD. Other Arents.
Udarents, p. 203

Torriarents

Torriarents are the Arents that have a torric soil moisture regime.

---

[7] The carbon should be of Holocene age. It is not the intent to include fossil carbon from transported fragments of bedrock or from buried Pleistocene deposits. The mean residence time of the carbon should be less than 11,000 years B.P.

Cryofluvents

Key to subgroups

KDAA. Cryofluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryofluvents

KDAB. Other Cryofluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryofluvents

KDAC. Other Cryofluvents that have mottles that have chroma of 2 or less within 50 cm of the soil surface.

Aquic Cryofluvents

KDAD. Other Cryofluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Cryofluvents

KDAE. Other Cryofluvents.

Typic Cryofluvents

Torrifluvents

Key to subgroups

KDDA. Torrifluvents that:

1. Have *all three* of the following characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole

KDDD. Other Torrifluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Torrifluvents

KDDE. Other Torrifluvents that:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains as much as 20 percent durinodes or is brittle and has firm consistence when moist; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.
Durorthidic Xeric Torrifluvents

KDDD. Other Torrifluvents that have a horizon within 100 cm of the surface that is more than 15 cm thick that either contains as much as 20 percent durinodes or is brittle and has firm consistence when moist.
Durorthidic Torrifluvents

KDDE. Other Torrifluvents that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a torric moisture regime that borders on an ustic regime.
Ustic Torrifluvents

KDDF. Other Torrifluvents that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.
Xeric Torrifluvents

KDDG. Other Torrifluvents that have an anthropic epipedon.
Anthropic Torrifluvents

KDDH. Other Torrifluvents.
Typic Torrifluvents

Tropofluvents

Tropofluvents are the Fluvents that

1. Have an isomesic or warmer *iso* temperature regime; *and*

2. Have a udic moisture regime.

Only one series of Tropofluvents has been recognized in the United States, and subgroups have not been defined. It is suggested that the definition of the typic subgroup should parallel that of Typic Udifluvents in the great group that is defined next.

Udifluvents

Key to subgroups

KDFA. Udifluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Udifluvents

KDFB. Other Udifluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Udifluvents

KDFC. Other Udifluvents that have mottles within 50 cm of the surface that have chroma of 2 or less or, at a depth between 50 and 100 cm, have one or more horizons that are saturated with water at some period or that are artificially drained and have chroma less than 1 or hue bluer than 10Y and value, moist, of 4 or more.

Aquic Udifluvents

KDFD. Other Udifluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Udifluvents

KDFE. Other Udifluvents.

Typic Udifluvents

KDBB. Other Xerofluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Xerofluvents

KDBC. Other Xerofluvents that:

1. Are saturated with water within 150 cm of the surface during any period in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.
Aquic Durorthidic Xerofluvents

KDBD. Other Xerofluvents that are saturated with water within 150 cm of the surface during any period in most years.
Aquic Xerofluvents

KDBE. Other Xerofluvents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.
Durorthidic Xerofluvents

KDBF. Other Xerofluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.
Mollic Xerofluvents

KDBG. Other Xerofluvents.
Typic Xerofluvents

ORTHENTS

Key to great groups

KEA. Orthents that have a cryic or pergelic temperature regime.
Cryorthents, p. 210

KEB. Other Orthents that have a torric moisture regime.
Torriorthents, p. 211

Torriorthents

Key to subgroups

KEBA. Torriorthents that:

1. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. Unless irrigated, they have cracks that remain open from 175 to 240 days, cumulative, and are not closed for as many as 60 consecutive days during the 120 days following the winter solstice in 3 or more years out of 10 if the soil temperature regime is thermic, mesic, or frigid.

Ustertic Torriorthents

KEBB. Other Torriorthents that:

1. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. Have a thermic, mesic, or frigid soil temperature regime and have cracks that are closed for 60 consecutive days or more during the 120 days following the winter solstice in more than 7 years out of 10.

Xerertic Torriorthents

KEBC. Other Torriorthents that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm

long in some part, and that extend upward to the soil surface or the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Torriorthents

KEBD. Other Torriorthents that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they either (1) have a hyperthermic or an iso soil temperature regime or (2) have a thermic, mesic or frigid soil temperature regime and have an aridic moisture regime that borders on an ustic regime.

Lithic Ustic Torriorthents

KEBE. Other Torriorthents that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they have a thermic, mesic, or frigid soil temperature regime and an aridic moisture regime that borders on a xeric regime.

Lithic Xeric Torriorthents

KEBF. Other Torriorthents that have a lithic contact within 50 cm of the surface.

Lithic Torriorthents

KEBG. Other Torriorthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Torriorthents

KEBH. Other Torriorthents that:

1. Are saturated with water within 150 cm of the surface at any time of year in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Aquic Durorthidic Torriorthents

KEBI. Other Torriorthents that are saturated with water within 150 cm of the surface at any time of year in most years.

Aquic Torriorthents

KEBJ. Other Torriorthents that:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist; *and*

2. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they have a thermic, mesic, or frigid soil temperature regime and have a torric moisture regime that borders on a xeric regime.

Durorthidic Xeric Torriorthents

KEBK. Other Torriorthents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Torriorthents

KEBL. Other Torriorthents that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they either (1) have a hyperthermic or an iso soil temperature regime or (2) have a thermic, mesic, or a frigid soil temperature regime and have an aridic moisture regime that borders on an ustic regime.

Ustic Torriorthents

KEBM. Other Torriorthents that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.

Xeric Torriorthents

KEBN. Other Torriorthents.

Typic Torriorthents

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Udorthents

KEED. Other Udorthents that are saturated with water for as long as 1 month within 150 cm of the surface.

Aquic Udorthents

KEEE. Other Udorthents that have 50 percent or more by volume of wormholes, wormcasts, and filled animal burrows between the bottom of the Ap horizon or a depth of 25 cm, whichever is deeper, and a depth of 100 cm or a lithic or paralithic or petroferric contact, whichever is shallower.

Vermic Udorthents

KEEF. Other Udorthents.

Typic Udorthents

Ustorthents

Key to subgroups

KEFA. Other Ustorthents that have a lithic contact within 50 cm of the surface.

Lithic Ustorthents

KEFB. Ustorthents that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Ustorthents

KEFC. Other Ustorthents that are saturated with water within 150 cm of the surface for as long as 1 month in most years.

Aquic Ustorthents

KEFD. Other Ustorthents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Ustorthents

KECF. Other Xerorthents that have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface.
Dystric Xerorthents

KEDG. Other Xerorthents.
Typic Xerorthents

PSAMMENTS

Key to great groups

KCA. Psamments that have a cryic or pergelic soil temperature regime.
Cryopsamments, p. 217

KCB. Other Psamments that have a torric moisture regime.
Torripsamments, p. 219

KCC. Other Psamments that have, in the particle size control section, more than 90 percent silica minerals (quartz, chalcedony or opal) or other extremely durable minerals in the 0.02 to 2.0 mm fraction that are resistant to weathering.
Quartzipsamments, p. 218

KCD. Other Psamments that have a udic moisture regime and mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more.
Udipsamments, p. 220

KCE. Other Psamments that have a udic moisture regime.
Tropopsamments, p. 220

KCF. Other Psamments that have a xeric moisture regime.
Xeropsamments, p. 222

KCG. Other Psamments.
Ustipsamments, p. 221

Cryopsamments

Key to subgroups

KCAA. Cryopsamments that have a lithic contact within 50 cm of the soil surface.
Lithic Cryopsamments

KCAB. Other Cryopsamments that have a mean annual soil temperature that is 0°C or lower.
Pergelic Cryopsamments

KCAC. Other Cryopsamments that have mottles that have chroma of 2 or less within 50 cm of the soil surface.
Aquic Cryopsamments

KCAD. Other Cryopsamments that have an albic horizon that is 5 cm or more thick and underlain by a horizon that has a color value one unit or more darker and that

or more durinodes or is brittle and has firm consistence when moist; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on xeric.

Durorthidic Xeric Torripsamments

KCBC. Other Torripsamments that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Torripsamments

KCBD. Other Torripsamments that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and have a torric moisture regime that borders on an ustic regime.

Ustic Torripsamments

KCBE. Other Torripsamments that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.

Xeric Torripsamments

KCBF. Other Torripsamments.

Typic Torripsamments

Tropopsamments

Key to subgroups

KCEA. Tropopsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Tropopsamments

KCEB. Tropopsamments that have mottles above a depth of 100 cm that have chroma of 2 or less, or if the color is due to uncoated sand grains, have a ground-water table within 100 cm of the soil surface for 60 or more cumulative days in most years.

Aquic Tropopsamments

KCEC. Other Tropopsamments.

Typic Tropopsamments

Udipsamments

Key to subgroups

KCDA. Udipsamments that have a lithic contact within a depth of 50 cm.

Lithic Udipsamments

KCDB. Other Udipsamments that have mottles that have chroma of 2 or less above a depth of 100 cm.

Aquic Udipsamments

KCDC. Other Udipsamments that have an albic horizon that is thick enough to be preserved after the soil has been mixed to a depth of 18 cm and is underlain by a horizon that has a color value one unit or more darker and that meets all requirements for a spodic horizon except the index of accumulation.

Spodic Udipsamments

KCDD. Other Udipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness[12], and either have base saturation of 35 percent or more at a depth of 125 cm below the uppermost lamella or have a frigid temperature regime.

Alfic Udipsamments

KCDE. Other Udipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[13]

Ultic Udipsamments

KCDF. Other Udipsamments that have a surface horizon between 25 and 50 cm thick that meets all requirements for a plaggen epipedon except thickness.

Plaggeptic Udipsamments

KCDG. Other Udipsamments.

Typic Udipsamments

Ustipsamments

Key to subgroups

KCGA. Ustipsamments that have a lithic contact within 50 cm of the surface.

Lithic Ustipsamments

KCGB. Other Ustipsamments that have distinct or prominent mottles above a depth of 100 cm or are saturated with water within 100 cm of the surface during some time of year in most years.

Aquic Ustipsamments

KCGC. Other Ustipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness[14] and base

---

12 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

13 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

14 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

saturation of 35 percent or more at a depth of 125 cm below the uppermost lamella.

Alfic Ustipsamments

KCGD. Other Ustipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[15]

Ultic Ustipsamments

KCGE. Other Ustipsamments.

Typic Ustipsamments

Xeropsamments

Key to subgroups

KCFA. Xeropsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Xeropsamments

KCFB. Other Xeropsamments that:

1. Have distinct or prominent mottles above a depth of 100 cm or are saturated with water within 100 cm of the surface during some time of year in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist.

Aquic Durorthidic Xeropsamments

KCFC. Other Xeropsamments that have distinct or prominent mottles above a depth of 100 cm or are saturated with water within 100 cm of the surface during some time of year in most years.

Aquic Xeropsamments

KCFD. Other Xeropsamments that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Xeropsamments

KCFE. Other Xeropsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness[16] and have base saturation of 35 percent or more at a depth of 125 cm below the uppermost lamella.

Alfic Xeropsamments

KCFF. Other Xeropsamments that have lamellae within

15 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

16 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[17]

Ultic Xeropsamments

KCFG. Other Xeropsamments that have base saturation (by NH_4OAc) of less than 60 percent throughout the soil between depths of 25 and 75 cm below the soil surface.

Dystric Xeropsamments

KCFH. Other Xeropsamments.

Typic Xeropsamments

---

[17] The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

Chapter 9

Histosols

KEY TO SUBORDERS

AA. Histosols that are never saturated with water for more than a few days following heavy rains; *and*

1. Have a lithic or paralithic contact less than 100 cm from the surface or have fragmental materials in which the interstices are filled or partly filled with organic materials in half or more of each pedon, or both; *and*

2. Less than three-fourths of the thickness of organic materials consists of *Sphagnum* fibers.

Folists, p. 231

AB. Other Histosols that

1. Are dominantly[1] fibric in the subsurface tier if that tier is wholly organic except for a thin mineral layer or layers, or the organic parts of the surface and subsurface tiers are dominantly fibric if a continuous mineral layer 40 cm or more thick begins within the depth limit of the subsurface tier; *or*

2. Have a surface mantle that has three-fourths or more of its volume consisting of fibers derived from *Sphagnum* and that rests on a lithic or paralithic contact, fragmental materials, or mineral soil, or on frozen[2] materials within the limits in depth of the surface or subsurface tier; *and*

3. Do not have a sulfuric horizon whose upper boundary is within 50 cm of the surface and do not have sulfidic materials within 100 cm of the surface.

Fibrists, p. 226

AC. Other Histosols that

1. Are dominantly hemic in the subsurface tier if that tier is wholly organic except for a thin mineral layer or layers; or are dominantly hemic in the organic part of the surface and subsurface tiers if a continuous mineral layer 40 cm or more thick begins within the depth limits of the subsurface tier; *or*

2. Have a sulfuric horizon whose upper boundary is within 50 cm of the surface or have sulfidic materials within 100 cm of the surface.

Hemists, p. 232

---

[1] Dominant, in this context, means the most abundant. If only two kinds of organic materials are present, the fibric materials occupy half or more of the volume. If there are both hemic and sapric materials as well as fibric, the fibric materials may occupy less than half of the volume but have more volume than either the hemic or sapric materials.

[2] Frozen 2 months after the summer solstice.

AD. Other Histosols.

Saprists, p. 237

FIBRISTS

Key to great groups

ABA. Fibrists that have a surface mantle that is three-fourths or more fibric *Sphagnum* spp. and that either is 90 cm or more thick, or extends 10 cm or more below permafrost, or rests on a lithic or paralithic contact, fragmental materials, or mineral soil materials.

Sphagnofibrists, p. 229

ABB. Other Fibrists that are frozen in most years in some layer within the control section about 2 months after the summer solstice or that are never frozen in most years below a depth of 5 cm but have a mean annual soil temperature that is lower than 8°C.

Cryofibrists, p. 227

ABC. Other Fibrists that have a mean annual soil temperature lower than 8°C.

Borofibrists, p. 226

ABD. Other Fibrists that have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 30 cm.

Tropofibrists, p. 230

ABE. Other Fibrists that do not have a horizon 2 cm or more thick consisting of half or more humilluvic materials.

Medifibrists, p. 228

ABF. Other Fibrists.

Luvifibrists, p. 228

Borofibrists

Key to subgroups

ABCA. Borofibrists that have a layer of water within the control section below the surface tier.

Hydric Borofibrists

ABCB. Other Borofibrists that have a lithic contact within the control section.

Lithic Borofibrists

ABCC. Other Borofibrists that:

1. Have three-fourths or more of the fibers (by volume) derived from *Sphagnum* in the surface tier or more of the control section; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sphagnic Terric Borofibrists

ABCD. Other Borofibrists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Borofibrists

ABCE. Other Borofibrists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Borofibrists

ABCF. Other Borofibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Borofibrists

ABCG. Other Borofibrists that have limnic layer(s) within the control section 5 cm or more thick.

Limnic Borofibrists

ABCH. Other Borofibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Borofibrists

ABCI. Other Borofibrists that have three-fourths or more of the fibers (by volume) derived from *Sphagnum* in the surface tier or more of the control section.

Sphagnic Borofibrists

ABCJ. Other Borofibrists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Borofibrists

ABCK. Other Borofibrists that have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Borofibrists

ABCL. Other Borofibrists.

Typic Borofibrists

Cryofibrists

Key to subgroups

ABBA. Cryofibrists that have a lithic contact within the control section.

Lithic Cryofibrists

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Medifibrists

ABEE. Other Medifibrists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Medifibrists

ABEF. Other Medifibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Medifibrists

ABEG. Other Medifibrists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Medifibrists

ABEH. Other Medifibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Medifibrists

ABEI. Other Medifibrists that have three-fourths or more of the fiber volume in the surface tier or more of the control section derived from *Sphagnum*.

Sphagnic Medifibrists

ABEJ. Other Medifibrists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Medifibrists

ABEK. Other Medifibrists that have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Medifibrists

ABEL. Other Medifibrists.

Typic Medifibrists

Sphagnofibrists

Key to subgroups

ABAA. Sphagnofibrists that:

1. Have a mean annual soil temperature of 0°C or less; *and*

2. Are frozen within the control section about 2 months after the summer solstice or are frozen below a depth of 5 cm in most years.

Pergelic Sphagnofibrists

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Tropofibrists

ABDD. Other Tropofibrists that:

1. Have 12.5 cm or more of the thickness of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Tropofibrists

ABDE. Other Tropofibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Tropofibrists

ABDF. Other Tropofibrists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Tropofibrists

ABDG. Other Tropofibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Tropofibrists

ABDH. Other Tropofibrists that have 25 cm or more of the thickness of the subsurface and bottom tiers consisting of hemic materials.

Hemic Tropofibrists

ABDI. Other Tropofibrists that have 12.5 cm or more of the thickness of the subsurface and bottom tiers consisting of sapric materials.

Sapric Tropofibrists

ABDJ. Other Tropofibrists.

Typic Tropofibrists

FOLISTS

Key to great groups

AAA. Folists that have a cryic or colder temperature regime.

Cryofolists, p. 232

AAB. Other Folists that have an isomesic or warmer temperature regime.

Tropofolists, p. 232

AAC. Other Folists that have a frigid temperature regime.

Borofolists, p. 232

subsurface and bottom tiers consisting of sapric materials.

Sapric Borohemists

ACEJ. Other Borohemists.

Typic Borohemists

Cryohemists

Key to subgroups

ACDA. Cryohemists that have a lithic contact within the control section.

Lithic Cryohemists

ACDB. Other Cryohemists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryohemists

ACDC. Other Cryohemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Cryohemists

ACDD. Other Cryohemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Cryohemists

ACDE. Other Cryohemists.

Typic Cryohemists

Luvihemists

Luvihemists are not known to occur in the United States but the great group is provided tentatively for use in other countries if needed. They are the Hemists that have a horizon that is 2 cm or more thick within the control section, and half or more of the volume of that horizon consists of humilluvic materials. Because these soils cannot be studied in the United States, a precise definition is not attempted here. It should be noted, however, that they are normally acid and that they have been cultivated for a long time.

Medihemists

Key to subgroups

ACGA. Medihemists that have a layer of water within the control section below the surface tier.

Hydric Medihemists

ACGB. Other Medihemists that have a lithic contact within the control section.

Lithic Medihemists

ACGC. Other Medihemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Medihemists

ACGD. Other Medihemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Medihemists

ACGE. Other Medihemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Medihemists

ACGF. Other Medihemists that have limnic layer(s) 5 cm or more thick within the control section.

Limnic Medihemists

ACGG. Other Medihemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Medihemists

ACGH. Other Medihemists that have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Medihemists

ACGI. Other Medihemists that have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Medihemists

ACGJ. Other Medihemists.

Typic Medihemists

Sulfihemists

Key to subgroups

ACBA. Sulfihemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Sulfihemists

ACBB. Other Sulfihemists.

Typic Sulfihemists

Sulfohemists

Key to subgroups

ACAA. All Sulfohemists (provisionally).

Typic Sulfohemists

Tropohemists

Key to subgroups

ACFA. Tropohemists that have a layer of water within the control section below the surface tier.

Hydric Tropohemists

ACFB. Other Tropohemists that have a lithic contact within the control section.

Lithic Tropohemists

ACFC. Other Tropohemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Tropohemists

ACFD. Other Tropohemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Tropohemists

ACFE. Other Tropohemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Tropohemists

ACFF. Other Tropohemists that have limnic layer(s) 5 cm or more thick within the control section.

Limnic Tropohemists

ACFG. Other Tropohemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Tropohemists

ACFH. Other Tropohemists that have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Tropohemists

ACFI. Other Tropohemists that have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Tropohemists

ACFJ. Other Tropohemists.

Typic Tropohemists

SAPRISTS

Key to great groups

ADA. Saprists that are frozen in some layer within the control section about 2 months after the summer solstice or that are never frozen below a depth of 5 cm but have a mean annual soil temperature lower than 8°C.

Cryosaprists, p. 238

ADB. Other Saprists that have a mean annual soil temperature lower than 8°C.

Borosaprists, p. 237

ADC. Other Saprists that have less than 5°C difference between mean summer and mean winter soil temperatures at a depth of 30 cm.

Troposaprists, p. 239

ADD. Other Saprists that do not have a horizon of humilluvic materials 2 cm or more thick.

Medisaprists, p. 238

Borosaprists

Key to subgroups

ADBA. Borosaprists that have a lithic contact within the control section.

Lithic Borosaprists

ADBB. Other Borosaprists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Borosaprists

ADBC. Other Borosaprists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Borosaprists

ADBD. Other Borosaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Borosaprists

ADBE. Other Borosaprists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Borosaprists

ADBF. Other Borosaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Borosaprists

ADBG. Other Borosaprists that have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Borosaprists

ADBH. Other Borosaprists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Borosaprists

ADBI. Other Borosaprists.

Typic Borosaprists

Cryosaprists

Key to subgroups

ADAA. Cryosaprists that have a lithic contact within the control section.

Lithic Cryosaprists

ADAB. Other Cryosaprists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryosaprists

ADAC. Other Cryosaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Cryosaprists

ADAD. Other Cryosaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Cryosaprists

ADAE. Other Cryosaprists.

Typic Cryosaprists

Medisaprists

Key to subgroups

ADDA. Medisaprists that have a lithic contact within the control section.

Lithic Medisaprists

ADDB. Other Medisaprists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Medisaprists

ADDC. Other Medisaprists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Medisaprists

ADDD. Other Medisaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Medisaprists

ADDE. Other Medisaprists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Medisaprists

ADDF. Other Medisaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Medisaprists

ADDG. Other Medisaprists that have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Medisaprists

ADDH. Other Medisaprists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Medisaprists

ADDI. Other Medisaprists.

Typic Medisaprists

Troposaprists

Key to subgroups

ADCA. Troposaprists that have a lithic contact within the control section.

Lithic Troposaprists

ADCB. Other Troposaprists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Troposaprists

ADCC. Other Troposaprists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Troposaprists

ADCD. Other Troposaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Troposaprists

ADCE. Other Troposaprists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Troposaprists

ADCF. Other Troposaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Troposaprists

ADCG. Other Troposaprists that have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Troposaprists

ADCH. Other Troposaprists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Troposaprists

ADCI. Other Troposaprists.

Typic Troposaprists

2. Have a mean annual soil temperature that is 0°C or lower.

Histic Pergelic Cryaquepts

JAEC. Other Cryaquepts that:

1. Have a histic epipedon that is discontinuous in each pedon; *and*

2. Have a mean annual soil temperature that is 0°C or lower.

Pergelic Ruptic-Histic Cryaquepts

JAED. Other Cryaquepts that:

1. Have an umbric epipedon; *and*

2. Have a mean annual soil temperature that is 0°C or lower.

Humic Pergelic Cryaquepts

JAEE. Other Cryaquepts that have a mean annual soil temperature that is 0°C or lower.

Pergelic Cryaquepts

JAEF. Other Cryaquepts that have a histic epipedon.

Histic Cryaquepts

JAEG. Other Cryaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Cryaquepts

JAEH. Other Cryaquepts that:

1. Have chroma of 3 or more in more than 40 percent of the mass of one or more horizons between depths of 15 and 50 cm; *and*

2. Have an umbric epipedon.

Aeric Humic Cryaquepts

JAIF. Other Haplaquepts that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a value, dry, of 5 or less when crushed and smoothed, or have an A horizon that is 15 cm or more thick if its color value, moist, is 3 or less; *and*

2. Have base saturation (by NH_4OAc) of less than 50 percent in some horizon and it does not increase with depth to a value of 50 percent or more.

Humic Haplaquepts

JAIG. Other Haplaquepts that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a value, dry, of 5 or less when crushed and smoothed, or have an A horizon that is 15 cm or more thick if its color value, moist, is 3 or less; *and*

2. Have base saturation (by NH_4OAc) of 50 percent or more throughout or it increases with depth to a value of 50 percent or more.

Mollic Haplaquepts

JAIH. Other Haplaquepts.

Typic Haplaquepts

Humaquepts

Key to subgroups

JAHA. Humaquepts that have an *n* value of 0.9 or more between depths of 50 and 80 cm, or of more than 0.7 in one or more layers between depths of 20 and 50 cm.

Hydraquentic Humaquepts

JAHB. Other Humaquepts that have a histic epipedon whose upper boundary is at or near the soil surface.

Histic Humaquepts

JAHC. Other Humaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Humaquepts

JAHD. Other Humaquepts that:

1. Have an epipedon that is 60 cm or more thick; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface.

Cumulic Humaquepts

JAHE. Other Humaquepts that have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface.

Fluvaquentic Humaquepts

JAHF. Other Humaquepts that have chroma of 3 or more, moist, and hue of 5Y or redder in more than 40 percent of the matrix in one or more subhorizons between depths of 15 and 75 cm.

Aeric Humaquepts

JAHG. Other Humaquepts.

Typic Humaquepts

Placaquepts

Key to subgroups

JABA. Placaquepts that have a histic epipedon.

Histic Placaquepts

JABB. Other Placaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Placaquepts

JABC. Other Placaquepts that do not have a continuous placic horizon within 100 cm of the soil surface throughout each pedon.

Haplic Placaquepts

JABD. Other Placaquepts.

Typic Placaquepts

Plinthaquepts

These are mainly Aquepts of intertropical regions. They have plinthite that forms a continuous phase or occupies more than half the matrix of some subhorizon deeper than 30 cm but within 125 cm of the soil surface. These are soils in which the ground-water level fluctuates appreciably during the year. Water is at or near the surface during the rainy season but drops during a dry season. Most of these soils are in relatively recent alluvium, probably of late- Pleistocene or Holocene age. Weatherable minerals are present in appreciable amounts. These soils are not known to occur in the United States, but the great group is provided because the soils are thought to be extensive in parts of the Amazon basin.

Sulfaquepts

Key to subgroups

JAAA. All Sulfaquepts (provisional).

Typic Sulfaquepts

Tropaquepts

Key to subgroups

JAGA. Tropaquepts that have *one or both* of the following:

1. Jarosite mottles and a pH between 3.5 and 4.0 (1:1 water, air dried slowly in shade) in some subhorizon within 50 cm of the soil surface; *or*

2. Jarosite mottles and a pH of less than 4.0 (1:1 water, air dried slowly in shade) in some subhorizon between depths of 50 and 150 cm.

Sulfic Tropaquepts

JAGB. Other Tropaquepts that have a lithic contact within 50 cm of the soil surface.

Lithic Tropaquepts

JAGC. Other Tropaquepts that have the following combination of characteristics:

1. Cracks at some time in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Tropaquepts

JAGD. Other Tropaquepts that have a histic epipedon that has its upper boundary at or near the surface.

Histic Tropaquepts

JAGE. Other Tropaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Tropaquepts

JAGF. Other Tropaquepts that have 5 percent or more (by volume) of plinthite in one or more subhorizons within 150 cm of the soil surface.

Plinthic Tropaquepts

JAGG. Other Tropaquepts that have in more than 40 percent of the matrix in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

1. If mottled and if the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma, moist, is 3 or more; if the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

2. If mottled and if the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

3. The chroma, moist, is 2 or more if not mottled.

Aeric Tropaquepts

JAGH. Other Tropaquepts.

Typic Tropaquepts

OCHREPTS

Key to great groups

JDA. Ochrepts that have a fragipan.

Fragiochrepts, p. 257

JDB. Other Ochrepts that have a duripan whose upper boundary is within 100 cm of the soil surface.

Durochrepts, p. 252

JDC. Other Ochrepts that have a cryic or pergelic temperature regime.

Cryochrepts, p. 251

JDD. Other Ochrepts that have an ustic moisture regime.

Ustochrepts, p. 258

JDE. Other Ochrepts that have a xeric moisture regime.

Xerochrepts, p. 260

JDF. Other Ochrepts that have *one or both* of the following:

1. Carbonates in the cambic horizon or in the C horizon but within the soil; *or*

2. Base saturation (by NH_4OAc) that is 60 percent or more in some subhorizon between depths of 25 and 75 cm below the soil surface.

Eutrochrepts, p. 255

JDG. Other Ochrepts.

Dystrochrepts, p. 253

Cryochrepts

Key to subgroups

JDCA. Cryochrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Cryochrepts

JDCB. Other Cryochrepts that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryochrepts

JDCC. Other Cryochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryochrepts

JDCD. Other Cryochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryochrepts

JDCE. Other Cryochrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage.

Aquic Cryochrepts

JDCF. Other Cryochrepts that have lamellae within 75 cm of the soil surface that meet all requirements for an argillic horizon except thickness.

Alfic Cryochrepts

JDCG. Other Cryochrepts that have base saturation (by NH_4OAc) that is less than 60 percent in all subhorizons within 75 cm of the surface.

Dystric Cryochrepts

JDCH. Other Cryochrepts.

Typic Cryochrepts

Durochrepts

Key to subgroups

JDBA. Durochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Durochrepts

JDBB. Other Durochrepts that have distinct or prominent mottles within the upper 30 cm.

Aquic Durochrepts

JDBC. Other Durochrepts that do not have a xeric moisture regime.

Ustic Durochrepts

JDBD. Other Durochrepts that:

1. Do not have a platy or massive indurated duripan; *and*

2. Have base saturation (by NH_4OAc) of less than 60 percent throughout the soil between depths of 25 and 75 cm below the soil surface.

Dystric Entic Durochrepts

JDBE. Other Durochrepts that do not have a platy or massive indurated duripan.

Entic Durochrepts

JDBF. Other Durochrepts that have base saturation (by NH_4OAc) of less than 60 percent throughout the soil between depths of 25 and 75 cm below the soil surface.

Dystric Durochrepts

JDBG. Other Durochrepts.

Typic Durochrepts

Dystrochrepts

Key to subgroups

JDGA. Dystrochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon in less than half of each pedon, and the base saturation (by sum of cations) in the subhorizon just above the lithic contact is 35 percent or more.

Lithic Ruptic-Alfic Dystrochrepts

JDGB. Other Dystrochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon in less than half of each pedon and have base saturation (by sum of cations) in the subhorizon just above the lithic contact that is less than 35 percent.

Lithic Ruptic-Ultic Dystrochrepts

JDGC. Other Dystrochrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Dystrochrepts

JDGD. Other Dystrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Dystrochrepts

JDGE. Other Dystrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Dystrochrepts

JDGF. Other Dystrochrepts that:

1. Have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at a time when its temperature is 5°C or higher, or the soil has artificial drainage; *and*

2. Have a content of organic carbon[4] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Fluvaquentic Dystrochrepts

JDGG. Other Dystrochrepts that have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at a time when its temperature is 5°C or higher, or the soil has artificial drainage.

Aquic Dystrochrepts

JDGH. Other Dystrochrepts that:

1. Have a content of organic carbon[5] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less; *and*

3. Have an Ap horizon that has a color value, moist, of 3 or less or a color value, dry, of 5 or less, crushed and smoothed, or the upper soil to a depth of 18 cm, after mixing, has these colors.

Fluventic Umbric Dystrochrepts

JDGI. Other Dystrochrepts that:

1. Have a content of organic carbon[6] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Dystrochrepts

---

[4] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

[5] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

[6] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

JDGJ. Other Dystrochrepts that have an Ap horizon that has a color value, moist, of 3 or less or a color value, dry, of 5 or less, crushed and smoothed, or the upper soil to a depth of 18 cm, after mixing, has these colors.

Umbric Dystrochrepts

JDGK. Other Dystrochrepts that have an argillic horizon in less than half of each pedon, and the base saturation (by sum of cations) at a depth of 125 cm below the upper boundary of the argillic horizon or in the subhorizon just above a lithic or paralithic contact is 35 percent or more.

Ruptic-Alfic Dystrochrepts

JDGL. Other Dystrochrepts that have an argillic horizon in less than half of each pedon, and the base saturation (by sum of cations) at a depth of 125 cm below the upper boundary of the argillic horizon or in the subhorizon just above a lithic or paralithic contact is less than 35 percent.

Ruptic-Ultic Dystrochrepts

JDGM. Other Dystrochrepts.

Typic Dystrochrepts

Eutrochrepts

Key to subgroups

JDFA. Eutrochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon in some part but in less than half of each pedon.

Lithic Ruptic-Alfic Eutrochrepts

JDFB. Other Eutrochrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Eutrochrepts

JDFC. Other Eutrochrepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Eutrochrepts

JDFD. Other Eutrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Eutrochrepts

JDFE. Other Eutrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Eutrochrepts

JDFF. Other Eutrochrepts that:

1. Have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Fluvaquentic Eutrochrepts

JDFG. Other Eutrochrepts that:

1. Have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage; *and*

2. Do not have carbonates within a depth of 100 cm in all parts of each pedon.

Aquic Dystric Eutrochrepts

JDFH. Other Eutrochrepts that have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage.

Aquic Eutrochrepts

JDFI. Other Eutrochrepts that:

1. Do not have carbonates within a depth of 100 cm in all parts of each pedon; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Dystric Fluventic Eutrochrepts

JDFJ. Other Eutrochrepts that:

1. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Eutrochrepts

JDFK. Other Eutrochrepts that have a sandy particle-size class from the soil surface to a depth of 50 cm or more.

Arenic Eutrochrepts

JDFL. Other Eutrochrepts that do not have carbonates within a depth of 100 cm in all parts of each pedon.

Dystric Eutrochrepts

JDFM. Other Eutrochrepts that have 40 percent or more carbonates, including the coarse fragments up to 75 mm in diameter, in and below the cambic horizon but above a lithic or paralithic contact and above a depth of 100 cm.

Rendollic Eutrochrepts

JDFN. Other Eutrochrepts that have an argillic horizon in some part but in less than half of each pedon.

Ruptic-Alfic Eutrochrepts

JDFO. Other Eutrochrepts.

Typic Eutrochrepts

Fragiochrepts

Key to subgroups

JDAA. Fragiochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragiochrepts

JDAB. Other Fragiochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

JDDC. Other Ustochrepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the soil surface or the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Ustochrepts

JDDD. Other Ustochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Ustochrepts

JDDE. Other Ustochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Ustochrepts

JDDF. Other Ustochrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage.

Aquic Ustochrepts

JDDG. Other Ustochrepts that:

1. Have a content of organic carbon[7] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2

---

[7] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Ustochrepts

JDDH. Other Ustochrepts that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry sixth-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature, at a depth of 50 cm, exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic or warmer, are moist in some or all parts of the soil moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm is higher than 8°C.

Aridic Ustochrepts

JDDI. Other Ustochrepts that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Ustochrepts

JDDJ. Other Ustochrepts.

Typic Ustochrepts

Xerochrepts

Key to subgroups

JDEA. Xerochrepts that have a lithic contact within 50 cm of the soil surface in some part but less than half of each pedon.

Ruptic-Lithic Xerochrepts

JDEB. Other Xerochrepts that:

1. Have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface; *and*

2. Have a lithic contact within 50 cm of the soil surface.
Dystric Lithic Xerochrepts

JDEC. Other Xerochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an intermittent cambic horizon.
Lithic Ruptic-Xerorthentic Xerochrepts

JDED. Other Xerochrepts that have a lithic contact within 50 cm of the soil surface.
Lithic Xerochrepts

JDEE. Other Xerochrepts that have a petrocalcic horizon within a depth of 100 cm of the soil surface.
Petrocalcic Xerochrepts

JDEF. Other Xerochrepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.
Vertic Xerochrepts

JDEG. Other Xerochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.
Andic Xerochrepts

JDEH. Other Xerochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Xerochrepts

JDEI. Other Xerochrepts that have a gypsic horizon within a depth of 100 cm of the soil surface.

Gypsic Xerochrepts

JDEJ. Other Xerochrepts that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface; *and*

2. Have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface.

Aquic Dystric Xerochrepts

JDEK. Other Xerochrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface.

Aquic Xerochrepts

JDEL. Other Xerochrepts that:

1. Have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Dystric Fluventic Xerochrepts

JDEM. Other Xerochrepts that:

1. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Xerochrepts

JDEN. Other Xerochrepts that have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface.

Dystric Xerochrepts

JDEO. Other Xerochrepts that have a calcic horizon or soft powdery lime within a depth of 150 cm if the weighted average particle-size class from depths of 25 to 100 cm is sandy or to a lithic or paralithic contact if one is shallower than 100 cm, or within a depth of 110 cm if the weighted average particle-size class is loamy, or within a depth of 90 cm if it is clayey.

Calcixerollic Xerochrepts

JDEP. Other Xerochrepts.

Typic Xerochrepts

PLAGGEPTS

Plaggepts are the soils that have a plaggen epipedon.

TROPEPTS

Key to great groups

JCA. Tropepts that have base saturation of less than 50 percent (by NH_4OAc) in some subhorizon between depths of 25 and 100 cm and have 12 kg or more organic carbon, exclusive of surface litter, per square meter in the soil to a depth of 100 cm, or to a lithic, paralithic, or petroferric contact if one is shallower than 100 cm, and do not have a sombric horizon.

Humitropepts, p. 267

JCB. Other Tropepts that have a sombric horizon.

Sombritropepts, p. 268

JCC. Other Tropepts that have an ustic moisture regime and have base saturation (by NH_4OAc) of 50 percent or more in all subhorizons between depths of 25 and 100 cm, or between 25 cm and a lithic, paralithic or petroferric contact if one is shallower than 100 cm.

Ustropepts, p. 268

JCD. Other Tropepts that have base saturation (by NH_4OAc) of 50 percent or more in all subhorizons between depths of 25 and 100 cm, or between 25 cm and a lithic or paralithic contact if one is shallower than 100 cm.

Eutropepts, p. 265

JCE. Other Tropepts.

Dystropepts, p. 263

Dystropepts

Key to subgroups

JCEA. Dystropepts that have a lithic contact within 50 cm of the soil surface.

Lithic Dystropepts

JCEB. Other Dystropepts that have a petroferric contact within 50 cm of the soil surface.

Petroferric Dystropepts

JCEC. Other Dystropepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more if the soil moisture regime is udic, or 0.07 or more if it is ustic, in a horizon or horizons at least 50 cm

thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm or 125 cm, respectively, of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm or 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Dystropepts

JCED. Other Dystropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Dystropepts

JCEE. Other Dystropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Dystropepts

JCEF. Other Dystropepts that have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time of year, or the soil has artificial drainage.

Aquic Dystropepts

JCEG. Other Dystropepts that:

1. Have a content of organic carbon[8] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Dystropepts

---

[8] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

JCEH. Other Dystropepts that:

1. Have an ustic moisture regime; *and*

2. Have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[9] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Ustoxic Dystropepts

JCEI. Other Dystropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[10] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Dystropepts

JCEJ. Other Dystropepts that have an ustic moisture regime.

Ustic Dystropepts

JCEK. Other Dystropepts.

Typic Dystropepts

Eutropepts

Key to subgroups

JCDA. Eutropepts that have a lithic contact within 50 cm of the soil surface.

Lithic Eutropepts

JCDB. Other Eutropepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil, or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Eutropepts

---

9 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

10 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

JCDC. Other Eutropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Eutropepts

JCDD. Other Eutropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Eutropepts

JCDE. Other Eutropepts that:

1. Have a content of organic carbon[11] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less; *and*

3. Have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year, or there is artificial drainage.

Fluvaquentic Eutropepts

JCDF. Other Eutropepts that have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year, or there is artificial drainage.

Aquic Eutropepts

JCDG. Other Eutropepts that:

1. Have a content of organic carbon[12] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

---

[11] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

[12] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

JCAF. Other Humitropepts that:

1. Have a content of organic carbon that decreases irregularly with depth to the base of the cambic horizon; *and*

2. Have slopes of 25 percent or less.

Fluventic Humitropepts

JCAG. Other Humitropepts that:

1. Have an ustic moisture regime; *and*

2. Have a CEC (by NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[13] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Ustoxic Humitropepts

JCAH. Other Humitropepts that have a CEC (by NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[14] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Humitropepts

JCAI. Other Humitropepts that have an ustic soil moisture regime.

Ustic Humitropepts

JCAJ. Other Humitropepts.

Typic Humitropepts

Sombritropepts

These soils are the dark, humus-rich Tropepts of perhumid, cool, hilly or mountainous regions. They have a sombric horizon in or below a cambic horizon. Most of them have an umbric epipedon, a perudic soil moisture regime, and an isomesic temperature regime. They are not known to occur in the United States and their classification has not been developed.

Ustropepts

Key to subgroups

JCCA. Ustropepts that have a lithic contact within 50 cm of the soil surface.

Lithic Ustropepts

---

13 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

14 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

JEC. Other Umbrepts that have a xeric moisture regime.
Xerumbrepts, p. 273

JED. Other Umbrepts.
Haplumbrepts, p. 271

Cryumbrepts

Key to subgroups

JEBA. Cryumbrepts that have a lithic contact within 50 cm of the surface in only part of each pedon.
Ruptic-Lithic Cryumbrepts

JEBB. Other Cryumbrepts that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have an umbric epipedon that is discontinuous in each pedon.
Lithic Ruptic-Entic Cryumbrepts

JEBC. Other Cryumbrepts that have a lithic contact within 50 cm of the surface.
Lithic Cryumbrepts

JEBD. Other Cryumbrepts that have a mean annual soil temperature of 0°C or lower.
Pergelic Cryumbrepts

JEBE. Other Cryumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.
Andic Cryumbrepts

JEBF. Other Cryumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Cryumbrepts

JEBG. Other Cryumbrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is 5°C or more, or there is artificial drainage.

Aquic Cryumbrepts

JEBH. Other Cryumbrepts that do not have a cambic horizon.

Entic Cryumbrepts

JEBI. Other Cryumbrepts.

Typic Cryumbrepts

Fragiumbrepts

Key to subgroups

The definitions that follow are incomplete because there are few of these soils in the United States.

JEAA. Fragiumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragiumbrepts

JEAB. Other Fragiumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragiumbrepts

JEAC. Other Fragiumbrepts that have mottles that have chroma of 2 or less within 50 cm of the soil surface.

Aquic Fragiumbrepts

JEAD. Other Fragiumbrepts.

Typic Fragiumbrepts

Haplumbrepts

Key to subgroups

JEDA. Haplumbrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Haplumbrepts

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Xerumbrepts

JECD. Other Xerumbrepts that have an umbric or mollic epipedon that is 50 cm or more thick.

Pachic Xerumbrepts

JECE. Other Xerumbrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is more than 5°C, or there is artificial drainage.

Aquic Xerumbrepts

JECF. Other Xerumbrepts that:

1. Have a content of organic carbon that decreases irregularly with depth; *and*

2. Have slopes of 25 percent or less.

Fluventic Xerumbrepts

JECG. Other Xerumbrepts that do not have a cambic horizon.

Entic Xerumbrepts

JECH. Other Xerumbrepts.

Typic Xerumbrepts

Chapter 11

Mollisols

KEY TO SUBORDERS

HA. Mollisols that have all the following:

1. An albic horizon that lies immediately below the mollic epipedon or that separates horizons that together meet all the requirements of a mollic epipedon; *and*

2. An argillic or a natric horizon; *and*

3. Chroma of 2 or less in the albic horizon or characteristics associated with wetness in the albic, argillic, or natric horizon, namely mottles or iron-manganese concretions larger than 2 mm or both.

Albolls, p. 277

HB. Other Mollisols that either have an aquic moisture regime or are artificially drained, and that have *one or more* of the following characteristics associated with wetness:

1. A histic epipedon overlying the mollic epipedon; *or*

2. An SAR of 13 or more (or sodium saturation of 15 percent or more) in the upper part of the mollic epipedon and decreasing SAR (or sodium saturation) with increasing depth below 50 cm; *or*

3. One of the following combinations of colors, moist:

a. If the lower part of the mollic epipedon[1] has chroma of 1 or less, there are *either*

(1) Distinct or prominent mottles in the lower part of the mollic epipedon; *or*

(2) A color value, moist, of 4 or more immediately below the mollic epipedon, or within 75 cm of the surface if a calcic horizon intervenes, and *one* of the following:

(a) If the hue is 10YR or redder and there are mottles, chroma is less than 1 or less on ped surfaces or in the matrix; if there are no mottles, chroma is less than 1; *or*

(b) If the hue is nearest 2.5Y and there are distinct or prominent mottles, chroma is 2 or less on ped surfaces or in the matrix; if there are no mottles, chroma is 1 or less; *or*

(c) If the nearest hue is 5Y or yellower and there are distinct or prominent mottles, chroma is 3 or

---

[1] If the molhc epipedon extends to a lithic contact within 30 cm of the surface, the requirement for mottles is waived.

less on ped surfaces or in the matrix; if there are no mottles, chroma is 1 or less; *or*

(d) The hue is bluer than 10Y or the color is neutral; *or*

(e) The color results from uncoated mineral grains; *or*

b. If the lower part of the mollic epipedon has chroma of more than 1 but not more than 2, there are *either*

(1) Distinct or prominent mottles in the lower mollic epipedon; *or*

(2) Base colors immediately below the mollic epipedon that have *one or more* of the following properties:

(a) Value of 4 and chroma of 2 and also some mottles that have value of 4 or more and chroma less than 2; *or*

(b) Value of 5 or more and chroma of 2 or less and also mottles that have higher chroma; *or*

(c) Value of 4 and chroma less than 2; *or*

4. A calcic or petrocalcic horizon that has its upper boundary within 40 cm of the surface.

Aquolls, p. 278

HC. Other Mollisols that have all the following characteristics:

1. Have a mollic epipedon that is not more than 50 cm thick; *and*

2. Do not have an argillic horizon; *and*

3. Do not have a calcic horizon; *and*

4. The soil materials in or immediately below any mollic epipedon, including coarse fragments less than 7.5 cm in diameter, have a $CaCO_3$ equivalent of 40 percent or more; *and*

5. Have a udic moisture regime or a cryic temperature regime.

Rendolls, p. 296

HD. Other Mollisols that have a xeric moisture regime or an aridic moisture regime bordering on xeric but do not have a cryic temperature regime.

Xerolls, p. 320

HE. Other Mollisols that have a frigid, cryic, or pergelic temperature regime.

Borolls, p. 282

HF. Other Mollisols that have an ustic or an aridic moisture regime that borders on ustic.

Ustolls, p. 302

HG. Other Mollisols.

Udolls, p. 297

ALBOLLS

Key to great groups

HAA. Albolls that have a natric horizon.

Natralbolls, p. 278

HAB. Other Albolls.

Argialbolls, p. 277

Argialbolls

Key to subgroups

HABA. Argialbolls that:

1. Do not have an abrupt textural change from the albic to the argillic horizon; *and*

2. When not irrigated, are dry in all parts of the moisture control section for as long as 45 consecutive days during the 120 days following the summer solstice in more than 6 out of 10 years.

Argiaquic Xeric Argialbolls

HABB. Other Argialbolls that do not have an abrupt textural change from the albic to the argillic horizon.

Argiaquic Argialbolls

HABC. Other Argialbolls that, when not irrigated, are dry in all parts of the moisture control section for as long as 45 consecutive days during the 120 days following the summer solstice in more than 6 out of 10 years.

Xeric Argialbolls

HABD. Other Argialbolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

HBEC. Other Argiaquolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface of the soil or to the base of the Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the soil to a depth of 100 cm or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Argiaquolls

HBED. Other Argiaquolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary.

Abruptic Argiaquolls

HBEE. Other Argiaquolls.

Typic Argiaquolls

Calciaquolls

Key to subgroups

HBDA. Calciaquolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the surface.

Petrocalcic Calciaquolls

HBDB. Other Calciaquolls that have color that has dominant chroma of 3 or more in the matrix or on the ped surfaces in one or more subhorizons within 75 cm of the surface or have one of the following colors immediately below the mollic epipedon:

1. If the hue is 2.5Y or yellower and there are distinct or prominent mottles, the chroma, moist, is 3 or more; if there are no mottles, the chroma, moist, is 2 or more; *or*

2. If the hue is 10YR or redder the chroma, moist, is 2 or more.

Aeric Calciaquolls

HBDC. Other Calciaquolls.

Typic Calciaquolls

Cryaquolls

Key to subgroups

HBAA. Cryaquolls that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryaquolls

HBAB. Other Cryaquolls that have a histic epipedon.

Histic Cryaquolls

HBFB. Other Haplaquolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplaquolls

HBFC. Other Haplaquolls that have a histic epipedon.

Histic Haplaquolls

HBFD. Other Haplaquolls that have a buried Histosol that has its upper boundary within 100 cm of the soil surface.

Thapto-Histic Haplaquolls

HBFE. Other Haplaquolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Haplaquolls

HBFF. Other Haplaquolls that have a horizon 15 cm or more thick that is within 100 cm of the surface and that contains at least 20 percent (by volume) of durinodes or is brittle and has firm consistence when moist.

Duric Haplaquolls

HBFG. Other Haplaquolls that have a mollic epipedon that is 60 cm or more thick.

Cumulic Haplaquolls

HBFH. Other Haplaquolls that have slope of less than 25 percent; *and*

1. Have a content of organic carbon that decreases irregularly with increasing depth; *or*

2. Have more than 0.3 percent carbon in all subhorizons within 125 cm of the soil surface.
Fluvaquentic Haplaquolls

HBFI. Other Haplaquolls.
Typic Haplaquolls

Natraquolls

Key to subgroups

HBCA. All Natraquolls (provisional).
Typic Natraquolls

BOROLLS

Key to great groups

HEA. Borolls that have an argillic horizon that has its upper boundary deeper than 60 cm below the mineral soil surface[2], and that have texture finer than loamy fine sand in all subhorizons above the argillic horizon.
Paleborolls, p. 295

HEB. Other Borolls that have a cryic or pergelic temperature regime.
Cryoborolls, p. 286

HEC. Other Borolls that have a natric horizon but do not have a cambic horizon that is above the natric horizon and separated from it by an albic horizon.
Natriborolls, p. 294

HED. Other Borolls that have an argillic horizon but do not have a cambic horizon that is above the argillic horizon and separated from it by an albic horizon.
Argiborolls, p. 283

HEE. Other Borolls that have a mollic epipedon that, below any Ap horizon, is 50 percent or more by volume wormholes, wormcasts, or filled animal burrows and that either rests on a lithic contact or has a transition to the underlying horizon in which 25 percent or more of the material is discrete wormholes, wormcasts, or animal burrows filled with material from the mollic epipedon and the underlying horizon.
Vermiborolls, p. 296

HEF. Other Borolls that have a calcic or petrocalcic horizon whose upper boundary is within 100 cm of the soil surface and that are calcareous in all parts of all horizons above the calcic or petrocalcic horizon, after the upper soil to a depth of 18 cm has been mixed, unless the texture is coarser than loamy very fine sand.
Calciborolls, p. 286

---

[2] If there is a surface mantle that has 60 percent or more vitric volcanic ash, cinders, or other vitric pyroclastic materials, the depth to the argillic horizon is measured from the base of this mantle rather than from the mineral soil surface.

HEG. Other Borolls.

Haploborolls, p. 290

Argiborolls

Key to subgroups

HEDA. Argiborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Argiborolls

HEDB. Other Argiborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary; *and*

2. Have either or both

a. A color value, dry, of 5 or more in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *or*

b. A moisture control section that is dry in some part six-tenths or more of the time in most years that the soil temperature at a depth of 50 cm is above 5°C.

Abruptic Aridic Argiborolls

HEDC. Other Argiborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary; *and*

2. Have a chroma (rubbed), moist, of 1 or less in the upper 18 cm of the mollic epipedon after mixing, or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Abruptic Udic Argiborolls

HEDD. Other Argiborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary; *and*

2. Have an albic horizon immediately below the mollic epipedon; *and*

3. Have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water for as long as 90 days within 100 cm of the surface.

Albic Argiborolls

HEDE. Other Argiborolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary.

Abruptic Argiborolls

HEDF. Other Argiborolls that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

   b. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

   c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. Have both

   a. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

   b. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Ustertic Argiborolls

HEDG. Other Argiborolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Argiborolls

HEDH. Other Argiborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Argiborolls

HEDI. Other Argiborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and

2. Have an albic horizon immediately below the mollic epipedon; *and*

3. Have a lithic contact within a depth of 50 cm of the surface.

Boralfic Lithic Cryoborolls

HEBB. Other Cryoborolls that have an argillic horizon that is continuous throughout each pedon, and have a lithic contact within a depth of 50 cm of the surface.

Argic Lithic Cryoborolls

HEBC. Other Cryoborolls that have a lithic contact within a depth of 50 cm of the surface and have a mollic epipedon that is discontinuous in each pedon.

Lithic Ruptic-Entic Cryoborolls

HEBD. Other Cryoborolls that have a lithic contact within a depth of 50 cm of the surface and have an argillic horizon that is intermittent in each pedon.

Lithic Ruptic-Argic Cryoborolls

HEBE. Other Cryoborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Cryoborolls

HEBF. Other Cryoborolls that have a mean annual soil temperature of 0°C or less.

Pergelic Cryoborolls

HEBG. Other Cryoborolls that have an argillic horizon and an SAR of 13 or more (or 15 percent or more saturation with exchangeable sodium) in the major part of the argillic horizon.

Natric Cryoborolls

HEBH. Other Cryoborolls that have an argillic horizon and the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Argic Vertic Cryoborolls

HEBI. Other Cryoborolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or the whole soil if a lithic or

paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Cryoborolls

HEBJ. Other Cryoborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryoborolls

HEBK. Other Cryoborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryoborolls

HEBL. Other Cryoborolls that have a duripan that has its upper boundary within 100 cm of the soil surface.

Duric Cryoborolls

HEBM. Other Cryoborolls that have an albic horizon immediately below the mollic epipedon and have an argillic horizon.

Boralfic Cryoborolls

HEBN. Other Cryoborolls that:

1. Have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of 25 percent or less.

Cumulic Cryoborolls

HEBO. Other Cryoborolls that:

1. Have a calcic horizon within or immediately below the mollic epipedon and do not have an argillic horizon in the lower part of the mollic epipedon; *and*

2. Have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand.

Calcic Pachic Cryoborolls

HEBP. Other Cryoborolls that:

1. Have an argillic horizon; *and*

2. Have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand.

Argic Pachic Cryoborolls

HEBQ. Other Cryoborolls that have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand.

Pachic Cryoborolls

HEBR. Other Cryoborolls that:

1. Have an argillic horizon; *and*

2. Have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface if artificially drained and, if undrained, are continuously saturated with water within a depth of 100 cm for 90 days or longer.

Argiaquic Cryoborolls

HEBS. Other Cryoborolls that:

1. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm of the surface; *and*

2. Have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface and, if undrained, are continuously saturated with water within a depth of 100 cm for 90 days or longer; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Cryoborolls

HEBT. Other Cryoborolls that have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface and, if undrained, are continuously saturated with water within a depth of 100 cm for 90 days or longer.

Aquic Cryoborolls

HEBU. Other Cryoborolls that:

1. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

2. Have a slope of less than 25 percent.

Fluventic Cryoborolls

HEBV. Other Cryoborolls that:

1. Have an argillic horizon; *and*

2. Have an albic horizon immediately below the mollic epipedon; *and*

3. Have an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary of the argillic horizon.
Abruptic Cryoborolls

HEBW. Other Cryoborolls that have an argillic horizon that is continuous throughout each pedon.
Argic Cryoborolls

HEBX. Other Cryoborolls that have a calcic horizon within or immediately below the mollic epipedon.
Calcic Cryoborolls

HEBY. Other Cryoborolls that have an albic horizon immediately below the mollic epipedon.
Albic Cryoborolls

HEBZ. Other Cryoborolls.
Typic Cryoborolls

Haploborolls

Key to subgroups

HEGA. Haploborolls that have a salic horizon that has its upper boundary within a depth of 75 cm below the surface.
Salorthidic Haploborolls

HEGB. Other Haploborolls that have a lithic contact within a depth of 50 cm in part of each pedon.
Ruptic-Lithic Haploborolls

HEGC. Other Haploborolls that have a lithic contact within a depth of 50 cm of the surface.
Lithic Haploborolls

HEGD. Other Haploborolls that:

1. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm or in any Ap horizon that is more than 18 cm thick, or the soil is not dry in all parts of the moisture control section at some time in most years; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon; *and*

b. Potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness.
Udertic Haploborolls

HEGE. Other Haploborolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon; *and*

2. Potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haploborolls

HEGF. Other Haploborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploborolls

HEGG. Other Haploborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haploborolls

HEGH. Other Haploborolls that:

1. Have a mollic epipedon 40 cm or more thick, and the epipedon does not have a sandy particle-size class in the major part, and there is no paralithic contact or a sandy contrasting layer between depths of 40 and 50 cm; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent and a concave shape; *and*

4. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm, or in any Ap horizon that is more

undrained, are continuously saturated with water in the mottled horizon for 90 days or more in most years.

Aquic Haploborolls

HEGN. Other Haploborolls that:

1. Have both of the following:

   a. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

   b. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent.

Torrifluventic Haploborolls

HEGO. Other Haploborolls that have the following combination of characteristics:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years; *and*

3. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color.

Torriorthentic Haploborolls

HEGP. Other Haploborolls that have both of the following:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Aridic Haploborolls

HEGQ. Other Haploborolls that have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; and have a slope of less than 25 percent.

Fluventic Haploborolls

HEGR. Other Haploborolls that:

1. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm, or in any Ap horizon that is more

HECE. Other Natriborolls that have tonguing or interfingering of an albic horizon more than 2.5 cm into the natric horizon.

Glossic Natriborolls

HECF. Other Natriborolls.

Typic Natriborolls

Paleborolls

Key to subgroups

HEAA. Paleborolls that:

1. Have a mean summer soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon or less than 8°C if there is an O horizon; *and*

2. Have a mollic epipedon that is 50 cm or more thick.

Cryic Pachic Paleborolls

HEAB. Other Paleborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below its upper boundary; *and*

2. Have a mean summer soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon or less than 8°C if there is an O horizon.

Abruptic Cryic Paleborolls

HEAC. Other Paleborolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below its upper boundary.

Abruptic Paleborolls

HEAD. Other Paleborolls that have a mean summer soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon or less than 8°C if there is an O horizon.

Cryic Paleborolls

HEAE. Other Paleborolls that have a mollic epipedon that is 50 cm or more thick.

Pachic Paleborolls

HEAF. Other Paleborolls that have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water in the mottled horizon for as long as 90 days in most years.

Aquic Paleborolls

HEAG. Other Paleborolls.

Typic Paleborolls

Vermiborolls

Key to subgroups

HEEA. Vermiborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Vermiborolls

HEEB. Other Vermiborolls that have both of the following:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Aridic Vermiborolls

HEEC. Other Vermiborolls that:

1. Have a mollic epipedon less than 75 cm thick; *and*

2. Have a chroma, moist, after rubbing, of 1 or less in the upper part of the mollic epipedon to a depth of 18 cm, after mixing, or in any Ap horizon that is more than 18 cm thick.

Hapludic Vermiborolls

HEED. Other Vermiborolls that have a chroma, moist, after rubbing, of 1 or less in the upper part of the mollic epipedon to a depth of 18 cm, after mixing, or in any Ap horizon that is more than 18 cm thick.

Udic Vermiborolls

HEEE. Other Vermiborolls that have a mollic epipedon less than 75 cm thick.

Haplic Vermiborolls

HEEF. Other Vermiborolls.

Typic Vermiborolls

RENDOLLS

Key to subgroups

HCAA. Rendolls that:

1. Have a soil temperature regime that is cryic or pergelic; *and*

2. Have a lithic contact within a depth of 50 cm of the surface.

Cryic Lithic Rendolls

HCAB. Other Rendolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Rendolls

HCAC. Other Rendolls that have a soil temperature regime that is cryic or pergelic.

Cryic Rendolls

of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Hapludolls

HGDD. Other Hapludolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Hapludolls

HGDE. Other Hapludolls that:

1. Have a mollic epipedon 60 cm or more thick with a texture finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface and no lithic or paralithic contact within a depth of 125 cm; *and*

3. Have a slope of 25 percent or less.

Cumulic Hapludolls

HGDF. Other Hapludolls that:

1. Have mottles within 40 cm of the surface and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C, or have a horizon 15 cm or more thick immediately below the mollic epipedon that:

a. Has a hue of 10YR or redder and chroma of 2 or less, or has mottles that have chroma of 2 or less and value of 4 or more and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C; *or*

b. Has a hue of 2.5Y or yellower and chroma of 3 or less; *and*

2. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Hapludolls

HGDG. Other Hapludolls that have mottles within 40 cm of the surface and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C, or have a horizon 15 cm or more thick immediately below the mollic epipedon that:

1. Has a hue of 10YR or redder and chroma of 2 or less, or has mottles that have chroma of 2 or less and value of 4 or more and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C; *or*

2. Has a hue of 2.5Y or yellower and chroma of 3 or less.

Aquic Hapludolls

HGDH. Other Hapludolls that:

1. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

2. Have a slope of less than 25 percent.

Fluventic Hapludolls

HGDI. Other Hapludolls that:

1. Have a mollic epipedon 60 cm or more thick with a texture finer than loamy fine sand; *and*

2. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color; or either the cambic horizon or the lower part of the epipedon have carbonates throughout; *and*

3. The mollic epipedon, below any Ap horizon, has 50 percent or more by volume of wormholes, wormcasts, or filled animal burrows.

Vermic Hapludolls

HGDJ. Other Hapludolls that do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color; or either the cambic horizon or the lower part of the epipedon have carbonates throughout.

Entic Hapludolls

HGDK. Other Hapludolls.

Typic Hapludolls

Paleudolls

Key to subgroups

HGAA. Paleudolls that have mottles that have chroma of 2 or less in the upper 50 cm of the argillic horizon, and the mottled horizon is saturated with water at some period

there is no lithic or paralithic contact within 50 cm of the surface of the soil.

Paleustolls, p. 317

HFD. Other Ustolls that do not have an argillic horizon above a calcic, gypsic, or petrocalcic horizon, and that have a calcic or gypsic horizon that has its upper boundary within 100 cm of the soil surface or that have a petrocalcic horizon that has its upper boundary within 150 cm of the surface, and that are calcareous in all overlying subhorizons after the upper soil to a depth of 18 cm has been mixed, unless the texture is coarser than loamy very fine sand or very fine sand.

Calciustolls, p. 307

HFE. Other Ustolls that have an argillic horizon.

Argiustolls, p. 303

HFF. Other Ustolls that have a mollic epipedon below any Ap horizon that is 50 percent or more by volume wormholes and wormcasts or filled animal burrows, and that either rests on a lithic contact or has a transition to the underlying horizon in which 25 percent or more of the material is discrete wormcasts or animal burrows filled with material from the mollic epipedon and the underlying horizon.

Vermustolls, p. 319

HFG. Other Ustolls.

Haplustolls, p. 310

Argiustolls

Key to subgroups

HFEA. Argiustolls that:

1. Have an albic horizon or other eluvial horizon above the argillic horizon that has a color value too high for a mollic epipedon and chroma too high for an albic horizon; *and*

2. Have a lithic contact within 50 cm of the surface.

Alfic Lithic Argiustolls

HFEB. Other Argiustolls that have a lithic contact within 50 cm of the surface.

Lithic Argiustolls

HFEC. Other Argiustolls that:

1. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. The cracks are open 6 months or more in most years.

Torrertic Argiustolls

HFED. Other Argiustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry in some or all parts of the moisture control section for four-tenths or less of the cumulative days when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

3. The cracks are open less than 135 days in most years.

Udertic Argiustolls

HFEE. Other Argiustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Argiustolls

HFEI. Other Argiustolls that have an albic horizon or other eluvial horizon above the argillic horizon that has a color value too high for a mollic epipedon and chroma too high for an albic horizon, and the mean annual soil temperature is lower than 10°C.

Boralfic Argiustolls

HFEJ. Other Argiustolls that have an albic horizon or other eluvial horizon above the argillic horizon that has a color value too high for a mollic epipedon and chroma too high for an albic horizon, and the mean annual soil temperature is 10°C or more.

Ustalfic Argiustolls

HFEK. Other Argiustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiustolls

HFEL. Other Argiustolls that have mottles that have chroma of 2 or less within 100 cm of the soil surface and are continuously saturated with water within 100 cm of the soil surface for 3 months or more in most years unless artificially drained.

Aquic Argiustolls

HFEM. Other Argiustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in some or all parts of the moisture control section (not necessarily the same part) in half or more years during the period when the soil temperature at a depth of 50 cm is higher than 5°C; *or*

2. If the soil temperature regime is hyperthermic, or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm is higher than 8°C.

Aridic Argiustolls

HFEN. Other Argiustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Argiustolls

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. The cracks are open more than 6 months in most years.

Torrertic Haplustolls

HFGF. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

3. The cracks are open less than 135 days in most years.

Udertic Haplustolls

HFGG. Other Haplustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *amd*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplustolls

HFGH. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Torroxic Haplustolls

HFGI. Other Haplustolls that have CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Haplustolls

HFGJ. Other Haplustolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplustolls

HFGK. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

horizon or the lower part of the mollic epipedon has carbonates throughout.

Entic Haplustolls

HFGY. Other Haplustolls.

Typic Haplustolls

Natrustolls

Key to subgroups

HFBA. Natrustolls that have visible crystals or nests of gypsum or more soluble salts within 40 cm of the surface.

Leptic Natrustolls

HFBB. Other Natrustolls that have one or more of the following characteristics within 100 cm of the surface:

1. Dominant chroma of 1 or less throughout and hue as yellow or yellower than 2.5 Y in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Dominant chroma of 2 or less and a decrease in the percentage of exchangeable sodium from the upper 25-centimeter layer to the underlying layer.

Aquic Natrustolls

HFBC. Other Natrustolls that, when neither irrigated not fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, or isomesic or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Natrustolls

HFBD. Other Natrustolls that have a brittle horizon 15 cm or more thick that is within 100 cm of the surface and that contains some opal coatings or 20 percent or more by volume durinodes.

Duric Natrustolls

HFBE. Other Natrustolls that have tonguing or interfingering of an albic horizon more than 2.5 cm into a natric horizon.

Glossic Natrustolls

HFBF. Other Natrustolls.

Typic Natrustolls

HFCC. Other Paleustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that have total thickness of more than 50 cm.

Vertic Paleustolls

HFCD. Other Paleustolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Paleustolls

HFCE. Other Paleustolls that have a petrocalcic horizon within 150 cm of the surface.

Petrocalcic Paleustolls

HFCF. Other Paleustolls that have mottles that have chroma of 2 or less within 100 cm of the surface if artificially drained or, if undrained in most years, are continuously saturated with water in the mottled horizon for 90 days or more.

Aquic Paleustolls

HFCG. Other Paleustolls that:

1. Are calcareous throughout after the upper soil to a depth of 18 cm has been mixed and have a calcic horizon within a depth of 100 cm if the particle-size class of the upper 50 cm of the argillic horizon is sandy, 60 cm if loamy, and 50 cm if clayey; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Calciorthidic Paleustolls

HFCH. Other Paleustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more

years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Paleustolls

HFCI. Other Paleustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Paleustolls

HFCJ. Other Paleustolls that are calcareous throughout after the upper soil to a depth of 18 cm has been mixed and have a calcic horizon within a depth of 100 cm if the particle-size class of the upper 50 cm of the argillic horizon is sandy, 60 cm if it is loamy, and 50 cm if it is clayey.

Calcic Paleustolls

HFCK. Other Paleustolls that are calcareous throughout after the upper soil to a depth of 18 cm has been mixed.

Entic Paleustolls

HFCL. Other Paleustolls.

Typic Paleustolls

Vermustolls

Key to subgroups

HFFA. Vermustolls that have a lithic contact within 50 cm of the surface.

Lithic Vermustolls

HFFB. Other Vermustolls that have a mollic epipedon that is 75 cm or more thick.

Pachic Vermustolls

HFFC. Other Vermustolls that have mottles that have chroma of 2 or less within 100 cm of the surface.

Aquic Vermustolls

HFFD. Other Vermustolls that have a cambic horizon.

Haplic Vermustolls

HFFE. Other Vermustolls that have a mollic epipedon less than 50 cm thick.

Entic Vermustolls

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Argixerolls

HDEG. Other Argixerolls that have an albic horizon above the argillic horizon and the mean annual soil temperature is lower than 10°C.

Boralfic Argixerolls

HDEH. Other Argixerolls that:

1. Have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, 110 cm if it is loamy, and 90 cm if it is clayey, or above a lithic contact that is shallower than these depths; *and*

2. Have a mollic epipedon that is 50 cm or more thick with a texture finer than loamy fine sand.

Calcic Pachic Argixerolls

HDEI. Other Argixerolls that:

1. Have a mollic epipedon that is 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part in the upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Pachic Ultic Argixerolls

HDEJ. Other Argixerolls that have a mollic epipedon that is 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argixerolls

HDEK. Other Argixerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface and are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part in the upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Aquultic Argixerolls

HDEL. Other Argixerolls that have mottles that have chroma of 2 or less within 75 cm of the surface and are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained.

Aquic Argixerolls

HDEM. Other Argixerolls that:

long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.

Vertic Calcixerolls

HDDC. Other Calcixerolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Calcixerolls

HDDD. Other Calcixerolls that have mottles within 75 cm of the surface that are due to segregation of iron or manganese, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained.

Aquic Calcixerolls

HDDE. Other Calcixerolls that have an aridic moisture regime.

Aridic Calcixerolls

HDDF. Other Calcixerolls that have a mollic epipedon that below any Ap horizon has 50 percent or more by volume wormholes, wormcasts, or filled animal burrows.

Vermic Calcixerolls

HDDG. Other Calcixerolls.

Typic Calcixerolls

Durixerolls

Key to subgroups

HDAA. Durixerolls that:

1. Have an aridic moisture regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

sesquioxides or that is indurated in some subhorizon below its upper boundary; *and*

2. Do not have an argillic horizon above the duripan.
Entic Durixerolls

HDAI. Other Durixerolls that do not have an argillic horizon above the duripan.
Haplic Durixerolls

HDAJ. Other Durixerolls that do not have a duripan that is massive, platy, or prismatic and that has half or more of its upper boundary indurated or coated with opal or opal and sesquioxides or that is indurated in some subhorizon below its upper boundary.
Argic Durixerolls

HDAK. Other Durixerolls.
Typic Durixerolls

Haploxerolls

Key to subgroups

HDFA. Haploxerolls that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part of the soil above the lithic contact.
Lithic Ultic Haploxerolls

HDFB. Other Haploxerolls that have a lithic contact within 50 cm of the soil surface.
Lithic Haploxerolls

HDFC. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

c. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.
Torrertic Haploxerolls

HDFD. Other Haploxerolls that have the following combination of characteristics:

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of 25 percent or less; *and*

4. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Cumulic Ultic Haploxerolls

HDFH. Other Haploxerolls that:

1. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of 25 percent or less.

Cumulic Haploxerolls

HDFI. Other Haploxerolls that:

1. Have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class between a depth of 25 and 100 cm, or between a depth of 25 cm and a lithic or paralithic contact that is shallower than 100 cm, is sandy; within 110 cm if the average particle-size class is loamy; or within 90 cm if it is clayey; *and*

2. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Calcic Pachic Haploxerolls

HDFJ. Other Haploxerolls that:

1. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Pachic Ultic Haploxerolls

HDFK. Other Haploxerolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Haploxerolls

HDFL. Other Haploxerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Haploxerolls

HDFM. Other Haploxerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Aquic Duric Haploxerolls

HDFN. Other Haploxerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Aquultic Haploxerolls

HDFO. Other Haploxerolls that have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained.

Aquic Haploxerolls

HDFP. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of less than 25 percent.

Torrifluventic Haploxerolls

HDFQ. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Aridic Duric Haploxerolls

within 110 cm if the average particle-size class is loamy; or within 90 cm if it is clayey.

Calcic Haploxerolls

HDFZ. Other Haploxerolls that:

1. Do not have a cambic horizon, and the lower part of the epipedon does not meet the requirements of a cambic horizon except for color; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Entic Ultic Haploxerolls

HDFZa. Other Haploxerolls that have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Ultic Haploxerolls

HDFZb. Other Haploxerolls that do not have a cambic horizon, and the lower part of the epipedon does not meet the requirements of a cambic horizon except for color, or either the cambic horizon or the lower part of the epipedon has carbonates throughout.

Entic Haploxerolls

HDFZc. Other Haploxerolls.

Typic Haploxerolls

Natrixerolls

Key to subgroups

HDBA. Natrixerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Aquic Duric Natrixerolls

HDBB. Other Natrixerolls that have mottles that have chroma of 2 or less within 75 cm of the soil surface.

Aquic Natrixerolls

HDBC. Other Natrixerolls that have an aridic moisture regime.

Aridic Natrixerolls

HDBD. Other Natrixerolls that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Duric Natrixerolls

HDBE. Other Natrixerolls.

Typic Natrixerolls

cm or of less than 15 percent clay (absolute) within a distance of 2.5 cm at the upper boundary.

Haplic Palexerolls

HDCJ. Other Palexerolls.

Typic Palexerolls

DAC. Other Aquox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutraquox, p. 336

DAD. Other Aquox.

Haplaquox, p. 336

Acraquox

Key to subgroups

DAAA. Acraquox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Acraquox

DAAB. Other Acraquox that have mottles with chroma of more than 2 in 50 percent or more of the horizon immediately below the epipedon.

Aeric Acraquox

DAAC. Other Acraquox.

Typic Acraquox

Eutraquox

Key to subgroups

DACA. Eutraquox that have a histic epipedon.

Histic Eutraquox

DACB. Other Eutraquox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutraquox

DACC. Other Eutraquox that have mottles with chroma of more than 2 in 50 percent or more of the horizon immediately below the epipedon.

Aeric Eutraquox

DACD. Other Eutraquox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Eutraquox

DACE. Other Eutraquox.

Typic Eutraquox

Haplaquox

Key to subgroups

DADA. Haplaquox that have a histic epipedon.

Histic Haplaquox

DADB. Other Haplaquox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Haplaquox

DDCL. Other Eutroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Eutroperox

DDCM. Other Eutroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Eutroperox

DDCN. Other Eutroperox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Eutroperox

DDCO. Other Eutroperox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Eutroperox

DDCP. Other Eutroperox.

Typic Eutroperox

Haploperox

Key to subgroups

DDEA. Haploperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Haploperox

DDEB. Other Haploperox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Haploperox

DDEC. Other Haploperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Haploperox

DDED. Other Haploperox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Haploperox

DDEE. Other Haploperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Haploperox

DDEF. Other Haploperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Haploperox

DDEG. Other Haploperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Haploperox

DDEH. Other Haploperox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploperox

DDEI. Other Haploperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Haploperox

DDEJ. Other Haploperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Haploperox

DDEK. Other Haploperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Haploperox

DDEL. Other Haploperox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Haploperox

DDEM. Other Haploperox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Haploperox

DDEN. Other Haploperox.

Typic Haploperox

Kandiperox

Key to subgroups

DDDA. Kandiperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Kandiperox

DDDB. Other Kandiperox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Kandiperox

DDDC. Other Kandiperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm

DBBB. Other Eutrotorrox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutrotorrox

DBBC. Other Eutrotorrox.

Typic Eutrotorrox

Haplotorrox

Key to subgroups

DBCA. Haplotorrox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Haplotorrox

DBCB. Other Haplotorrox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Haplotorrox

DBCC. Other Haplotorrox.

Typic Haplotorrox

UDOX

Key to great groups

DEA. Udox that have a sombric horizon within a depth of 150 cm of the soil surface.

Sombriudox, p. 350

DEB. Other Udox that have both an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more in some part of the oxic or kandic horizon within a depth of 150 cm of the soil surface.

Acrudox, p. 344

DEC. Other Udox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutrudox, p. 346

DED. Other Udox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth of 150 cm of the surface.

Kandiudox, p. 349

DEE. Other Udox.

Hapludox, p. 347

Acrudox

Key to subgroups

DEBA. Acrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Acrudox

DEBM. Other Acrudox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Acrudox

DEBN. Other Acrudox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Acrudox

DEBO. Other Acrudox.

Typic Acrudox

Eutrudox

Key to subgroups

DECA. Eutrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Eutrudox

DECB. Other Eutrudox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Eutrudox

DECC. Other Eutrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Eutrudox

DECD. Other Eutrudox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutrudox

DECE. Other Eutrudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Eutrudox

DECF. Other Eutrudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutrudox

DECG. Other Eutrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Eutrudox

DECH. Other Eutrudox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth or 150 cm of the soil surface.

Kandiudalfic Eutrudox

DECI. Other Eutrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of

DEEE. Other Hapludox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Hapludox

DEEF. Other Hapludox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Hapludox

DEEG. Other Hapludox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Hapludox

DEEH. Other Hapludox that have the lower boundary of the oxic horizon within a depth or 125 cm of the soil surface.

Inceptic Hapludox

DEEI. Other Hapludox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Hapludox

DEEJ. Other Hapludox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Hapludox

DEEK. Other Hapludox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Hapludox

DEEL. Other Hapludox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Hapludox

DEEM. Other Hapludox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Hapludox

DEEN. Other Hapludox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Hapludox

DEEO. Other Hapludox.

Typic Hapludox

Kandiudox

Key to subgroups

DEDA. Kandiudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Kandiudox

DEDB. Other Kandiudox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Kandiudox

DEDC. Other Kandiudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Kandiudox

DEDD. Other Kandiudox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Kandiudox

DEDE. Other Kandiudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Kandiudox

DEDF. Other Kandiudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Kandiudox

DEDG. Other Kandiudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Kandiudox

DEDH. Other Kandiudox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandiudox

DEDI. Other Kandiudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Kandiudox

DEDJ. Other Kandiudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Kandiudox

DCE. Other Ustox.

Haplustox, p. 353

Acrustox

Key to subgroups

DCBA. Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Acrustox

DCBB. Other Acrustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Acrustox

DCBC. Other Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Acrustox

DCBD. Other Acrustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Acrustox

DCBE. Other Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Aquic Anionic Acrustox

DCBF. Other Acrustox that have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Anionic Acrustox

DCBG. Other Acrustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Acrustox

DCBH. Other Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Acrustox

DCBI. Other Acrustox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutric Acrustox

DCBJ. Other Acrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Acrustox

DCBK. Other Acrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Acrustox

DCBL. Other Acrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Acrustox

DCBM. Other Acrustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Acrustox

DCBN. Other Acrustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Acrustox

DCBO. Other Acrustox.

Typic Acrustox

Eutrustox

Key to subgroups

DCCA. Eutrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Eutrustox

DCCB. Other Eutrustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Eutrustox

DCCC. Other Eutrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Eutrustox

DCCD. Other Eutrustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutrustox

DCCE. Other Eutrustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Eutrustox

DCCF. Other Eutrustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutrustox

DCCG. Other Eutrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Eutrustox

DCCH. Other Eutrustox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth or 150 cm of the soil surface.

Kandiustalfic Eutrustox

DCCI. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Umbreptic Eutrustox

DCCJ. Other Eutrustox that have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Inceptic Eutrustox

DCCK. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Eutrustox

DCCL. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Eutrustox

DCCM. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Eutrustox

DCCN. Other Eutrustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Eutrustox

DCCO. Other Eutrustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Eutrustox

DCCP. Other Eutrustox.

Typic Eutrustox

Haplustox

Key to subgroups

DCEA. Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Haplustox

DCEB. Other Haplustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Haplustox

DCEC. Other Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Haplustox

DCED. Other Haplustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Haplustox

DCEE. Other Haplustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Haplustox

DCEF. Other Haplustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Haplustox

DCEG. Other Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and have the lower boundary of the oxic horizon within a depth or 125 cm of the soil surface.

Aqueptic Haplustox

DCEH. Other Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Haplustox

DCEI. Other Haplustox that have the lower boundary of the oxic horizon within a depth or 125 cm of the soil surface.

Inceptic Haplustox

DCEJ. Other Haplustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Haplustox

DCEK. Other Haplustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Haplustox

DCEL. Other Haplustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Haplustox

DCEM. Other Haplustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Haplustox

DCEN. Other Haplustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Haplustox

DCEO. Other Haplustox.

Typic Haplustox

Kandiustox

Key to subgroups

DCDA. Kandiustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Kandiustox

DCDB. Other Kandiustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Kandiustox

DCDC. Other Kandiustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Kandiustox

DCDD. Other Kandiustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Kandiustox

DCDE. Other Kandiustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Kandiustox

DCDF. Other Kandiustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Kandiustox

DCDG. Other Kandiustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Kandiustox

DCDH. Other Kandiustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Kandiustox

DCDI. Other Kandiustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Kandiustox

DCDJ. Other Kandiustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Kandiustox

DCDK. Other Kandiustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Kandiustox

DCDL. Other Kandiustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Kandiustox

DCDM. Other Kandiustox.

Typic Kandiustox

Sombriustox

Key to subgroups

DCAA. Sombriustox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Sombriustox

DCAB. Other Sombriustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Sombriustox

DCAC. Other Sombriustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Sombriustox

DCAD. Other Sombriustox.

Typic Sombriustox

Chapter 13

Spodosols

KEY TO SUBORDERS

CA. Spodosols that either have an aquic moisture regime[1] or are artificially drained and have characteristics associated with wetness, namely one or more of the following:

1. A histic epipedon; *or*

2. Mottling in an albic horizon or in the upper part of the spodic horizon; *or*

3. A duripan in the albic horizon; *or*

4. If free iron and manganese are absent or if the color value, moist, is less than 4 in the upper part of the spodic horizon, *either*

   a. Have any color if there are no coatings of iron oxides on the individual grains of silt and sand in or immediately below the spodic horizon wherever the value, moist, is 4 or more; *or*

   b. Have fine or medium mottles of iron or manganese in the materials immediately below the spodic horizon; *or*

5. A placic horizon that rests on a fragipan or on a spodic horizon or on an albic horizon that is underlain by a spodic horizon but is not in a spodic horizon.

Aquods, p. 357

CB. Other Spodosols that have a spodic horizon in which the ratio of free iron (by dithionite-citrate) to carbon (both elemental) is 6 or more in all subhorizons.

Ferrods, p. 363

CC. Other Spodosols that have a spodic horizon in which some subhorizon that is present in more than half of each pedon has a ratio of free iron to carbon of less than 0.2.

Humods, p. 363

CD. Other Spodosols.

Orthods, p. 367

AQUODS

Key to great groups

CAA. Aquods that have a fragipan below the spodic horizon but do not have a placic horizon above the fragipan.

Fragiaquods, p. 359

---

[1] If a placic horizon, duripan, or fragipan is present, the soil need not be saturated below that horizon.

CABG. Other Cryaquods.

Typic Cryaquods

Duraquods

Duraquods are the Aquods that have a duripan in the albic horizon and have a temperature regime warmer than that of Cryaquods.

Fragiaquods

Key to subgroups

CAAA. Fragiaquods that have a cryic or colder temperature regime.

Cryic Fragiaquods

CAAB. Other Fragiaquods that have a histic epipedon.

Histic Fragiaquods

CAAC. Other Fragiaquods that have 5 percent or more by volume of iron-cemented nodules 2.5 to 30 cm in diameter throughout the spodic horizon.

Sideric Fragiaquods

CAAD. Other Fragiaquods that have a surface horizon more than 30 cm thick that meets all requirements of a plaggen epipedon except thickness.

Plaggeptic Fragiaquods

CAAE. Other Fragiaquods that have an intermittent upper black subhorizon of the spodic horizon that has a ratio of free iron (elemental) to carbon that is less than 0.2; or if plowed and the Ap horizon rests directly on the spodic horizon, have tongues of such a subhorizon.

Humic Fragiaquods

CAAF. Other Fragiaquods that have an argillic or kandic horizon.

Alfic Fragiaquods

CAAG. Other Fragiaquods.

Typic Fragiaquods

Haplaquods

Key to subgroups

CAFA. Haplaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplaquods

CAFB. Other Haplaquods that have a placic horizon in or below the spodic horizon.

Placic Haplaquods

CAFC. Other Haplaquods that have a histic epipedon.

Histic Haplaquods

CAFD. Other Haplaquods that

CAGC. Other Sideraquods that have an argillic or kandic horizon.

Ultic Sideraquods

CAGD. Other Sideraquods that have a spodic horizon that *either*:

1. Is not very firm or firmer in any subhorizon when moist; *or*

2. Is 10 cm or less thick or contains less than 1.2 percent organic carbon in the upper 10 cm.

Entic Sideraquods

CAGE. Other Sideraquods.

Typic Sideraquods

Tropaquods

Key to subgroups

CAEA. Tropaquods that:

1. Have a histic epipedon; *and*

2. Have a lithic contact within 50 cm of the surface.

Histic Lithic Tropaquods

CAEB. Other Tropaquods that have a lithic contact within 50 cm of the surface.

Lithic Tropaquods

CAEC. Other Tropaquods that have a histic epipedon.

Histic Tropaquods

CAED. Other Tropaquods that

1. Have an umbric epipedon; *and*

2. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is deeper than 75 cm below the soil surface.

Arenic Umbric Tropaquods

CAEE. Other Tropaquods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface.

Aeric Arenic Tropaquods

CAEF. Other Tropaquods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 125 and 200 cm below the soil surface.

Aeric Grossarenic Tropaquods

CAEG. Other Tropaquods that have *either*

1. 5 percent or more by volume of iron-cemented nodules, 2.5 to 30 cm in diameter, throughout the spodic horizon; *or*

2. Have in less than 50 percent of each pedon a spodic horizon in which some subhorizon has a ratio of free iron (by dithionite-citrate) to carbon (both elemental) of less than 0.2.

Sideric Tropaquods

CAEH. Other Tropaquods that have an argillic or kandic horizon underlying the spodic horizon.

Ultic Tropaquods

CAEI. Other Tropaquods that have a spodic horizon that has a weighted average of less than 0.6 percent organic carbon in the matrix of the upper 30 cm of the spodic horizon, and the upper subhorizon of the spodic horizon *either*

1. Has less than 2.3 percent organic carbon in the upper 2 cm; *or*

2. The horizon with 2.3 percent or more organic carbon is present in 90 percent or less of each pedon.

Entic Tropaquods

CAEJ. Other Tropaquods that have an ochric epipedon, and the surface layer would not meet the requirements for an umbric epipedon if plowed to a depth of 25 cm.

Aeric Tropaquods

CAEK. Other Tropaquods.

Typic Tropaquods

FERRODS

This suborder is provisional. Ferrods are not known to occur in the United States, but the suborder is provided for use elsewhere. The classification has not been developed.

Ferrods are the Spodosols that

1. Have a spodic horizon that has in all subhorizons a ratio of percentage of free iron (by dithionite-citrate) to percentage of carbon (both elemental) of 6 or more; *and*

2. Do not have an aquic moisture regime or artificial drainage or do not have the characteristics associated with wetness as defined for Aquods.

HUMODS

Key to great groups

CCA. Humods that have a placic horizon in the spodic horizon.

Placohumods, p. 366

CCB. Other Humods that have an isomesic or warmer iso temperature regime.

Tropohumods, p. 366

CCC. Other Humods that have a fragipan below the spodic horizon.

Fragihumods, p. 364

CCD. Other Humods that have a cryic temperature regime.

Cryohumods, p. 364

CCE. Other Humods.

Haplohumods, p. 365

Cryohumods

Key to subgroups

CCDA. Cryohumods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryohumods

CCDB. Other Cryohumods that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryohumods

CCDC. Other Cryohumods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryohumods

CCDD. Other Cryohumods that have an intermittent placic horizon in the spodic horizon.

Placic Cryohumods

CCDE. Other Cryohumods that have an argillic or kandic horizon below the spodic horizon.

Alfic Cryohumods

CCDF. Other Cryohumods that have less than 6 percent organic carbon (weighted average) in the matrix of the upper 30 cm of the spodic horizon or, if the spodic horizon is less than 30 cm thick, in the 30 cm directly below the top of the spodic horizon.

Haplic Cryohumods

CCDG. Other Cryohumods.

Typic Cryohumods

Fragihumods

These are the Humods that have a fragipan below the spodic horizon and do not have a placic horizon. They are not known to occur in the United States, and the classification of subgroups has not been developed.

upper 30 cm of the spodic horizon or below any Ap horizon; *and*

2. Any black upper subhorizon of the spodic horizon that has 3 percent or more organic carbon in the upper 2 cm is present in 90 percent or less of the area of each pedon.

Entic Haplohumods

CCEG. Other Haplohumods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 125 and 200 cm below the soil surface.

Grossarenic Haplohumods

CCEH. Other Haplohumods that have 5 percent or more by volume of iron-cemented nodules, 2.5 to 30 cm in diameter, throughout the spodic horizon.

Ferrudalfic Haplohumods

CCEI. Other Haplohumods that have a surface horizon more than 30 cm thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Haplohumods

CCEJ. Other Haplohumods that have an argillic or kandic horizon below the spodic horizon.

Ultic Haplohumods

CCEK. Other Haplohumods that have less than 3 percent organic carbon in the upper 2 cm of the spodic horizon, or any black upper subhorizon of the spodic horizon that has 3 percent or more organic carbon in the upper 2 cm is present in less than 90 percent of the area of each pedon.

Orthic Haplohumods

CCEL. Other Haplohumods that have a xeric moisture regime.

Xeric Haplohumods

CCEM. Other Haplohumods.

Typic Haplohumods

Placohumods

Key to subgroups

CCAA. Placohumods that have a cryic or colder temperature regime.

Cryic Placohumods

CCAB. Other Placohumods.

Typic Placohumods

Tropohumods

Tropohumods are the Humods that have an isomesic or a warmer *iso* temperature regime.

ORTHODS

Key to great groups

CDA. Orthods that have a placic horizon in the spodic horizon.

Placorthods, p. 371

CDB. Other Orthods that have a fragipan below the spodic horizon.

Fragiorthods, p. 368

CDC. Other Orthods that have a cryic or pergelic temperature regime.

Cryorthods, p. 367

CDD. Other Orthods that have an isomesic or warmer iso temperature regime.

Troporthods, p. 371

CDE. Other Orthods.

Haplorthods, p. 369

Cryorthods

<u>Key to subgroups</u>

CDCA. Cryorthods that:

1. Have more than 6 percent organic carbon in the upper 10 cm of the spodic horizon; *and*

2. Have a lithic contact within 50 cm of the soil surface.

Humic Lithic Cryorthods

CDCB. Other Cryorthods that have a lithic contact within 50 cm of the soil surface.

Lithic Cryorthods

CDCC. Other Cryorthods that have a mean annual soil temperature of 0°C or less.

Pergelic Cryorthods

CDCD. Other Cryorthods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 <u>mm</u> fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryorthods

CDCE. Other Cryorthods that have an argillic or kandic horizon below the spodic horizon.

Boralfic Cryorthods

CDCE. Other Cryorthods that do not have a cemented or indurated spodic horizon and have less than 1.2 percent organic carbon in the upper 10 cm of the spodic horizon.

Entic Cryorthods

2. A texture of very fine sand or finer, and a thickness of more than 10 cm and at least 1.2 percent organic carbon (weighted average) in the upper 10 cm; *nor*

3. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma of 3 or less in at least the upper 7.5 cm.

Entic Fragiorthods

CDBH. Other Fragiorthods.

Typic Fragiorthods

Haplorthods

Key to subgroups

CDEA. Haplorthods that:

1. Have a spodic horizon that does *not* have any of the following:

a. A continuous horizon at least 2.5 cm thick that is very firm or extremely firm when moist (ortstein); *nor*

b. A texture of very fine sand or finer, and a thickness of more than 10 cm and a weighted average of at least 1.2 percent organic carbon in the upper 10 cm; *nor*

c. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma, moist, of 3 or less in at least the upper 7.5 cm of the spodic horizon; *and*

2. Have a lithic contact within 50 cm of the surface.

Entic Lithic Haplorthods

CDEB. Other Haplorthods that have a lithic contact within 50 cm of the surface.

Lithic Haplorthods

CDEC. Other Haplorthods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplorthods

CDED. Other Haplorthods that have a horizon 15 cm or more thick below the spodic horizon and within 100 cm of the surface that has a brittle matrix when wet or contains some durinodes.

Duric Haplorthods

CDEE. Other Haplorthods that:

1. Have distinct or prominent mottles of approximate spherical shape in the spodic horizon and the variability in color is not associated with differences in consistence in such a manner that the redder or darker parts are extremely firm or very firm, and, if

the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 days or more, cumulative, in most years; *or*

2. Have chroma of 2 or less if mottled, or chroma less than 2 if not mottled, that is dominant in the matrix within 15 cm below the base of the spodic horizon and within 100 cm of the surface of the soil; *and*

3. Have an argillic or kandic horizon below the spodic horizon, and the argillic or kandic horizon either has base saturation of 35 percent or more in some part or has a mean annual soil temperature lower than 8°C.

Aqualfic Haplorthods

CDEF. Other Haplorthods that:

1. Have distinct or prominent mottles of approximate spherical shape in the spodic horizon and the variability in color is not associated with differences in consistence in such a manner that the redder or darker parts are extremely firm or very firm, and, if the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 days or more, cumulative, in most years; *and*

2. Have a spodic horizon that does *not* have any of the following:

a. A continuous horizon at least 2.5 cm thick that is very firm or extremely firm when moist (ortstein); *nor*

b. A texture of very fine sand or finer, and a thickness of more than 10 cm and a weighted average of at least 1.2 percent organic carbon in the upper 10 cm; *nor*

c. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma, moist, of 3 or less in at least the upper 7.5 cm of the spodic horizon.

Aquentic Haplorthods

CDEG. Other Haplorthods that:

1. Have distinct or prominent mottles of approximate spherical shape in the spodic horizon and the variability in color is not associated with differences in consistence in such a manner that the redder or darker parts are extremely firm or very firm, and, if the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 days or more, cumulative, in most years; *or*

2. Have chroma of 2 or less if mottled, or chroma less than 2 if not mottled, that is dominant in the matrix within 15 cm below the base of the spodic horizon and within 100 cm of the surface of the soil.

Aquic Haplorthods

CDEH. Other Haplorthods that have an argillic or kandic horizon below the spodic horizon, and the argillic or kandic horizon either has base saturation of 35 percent or more in some part or has a mean annual soil temperature lower than 8°C.

Alfic Haplorthods

CDEI. Other Haplorthods that have an argillic or kandic horizon below the spodic horizon.

Ultic Haplorthods

CDEJ. Other Haplorthods that:

1. Have a black intermittent upper subhorizon that has a ratio of free iron (elemental) to carbon that is less than 0.2; *or*

2. Have 6 percent or more organic carbon in the upper 10 cm of the spodic horizon.

Humic Haplorthods

CDEK. Other Haplorthods that have a spodic horizon that does *not* have any of the following:

1. A continuous horizon at least 2.5 cm thick that is very firm or extremely firm when moist (ortstein); *nor*

2. A texture of very fine sand or finer, and a thickness of more than 10 cm and a weighted average of at least 1.2 percent organic carbon in the upper 10 cm; *nor*

3. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma, moist, of 3 or less in at least the upper 7.5 cm of the spodic horizon.

Entic Haplorthods

CDEL. Other Haplorthods.

Typic Haplorthods

Placorthods

These are the orthods that have a placic horizon in the spodic horizon. They are not known to occur in the United States, and they are thought to be rare elsewhere in the world. Subgroups have not been defined.

Troporthods

These are the Orthods that have an isomesic or warmer *iso* temperature regime. They are not known to occur in the United States, but the group is provided for use elsewhere. Subgroups have not been defined.

Albaquults

Key to subgroups

GACA. Albaquults that:

1. Have *one or more* of the following characteristics in more than 40 percent of the matrix between the Ap horizon and a depth of 75 cm:

a Dominant chroma, moist, of 3 or more if mottles of higher chroma are present; *or*

b. Chroma, moist, of 2 or more if mottles are absent; *or*

c. Dominant hue of 10YR or redder if distinct or prominent mottles are present and there is also a thermic, isothermic, or warmer soil temperature regime; *or*

2. Have an ochric epipedon that has higher chroma or redder hue, or both, than the underlying argillic or kandic horizon.

Aeric Albaquults

GACB. Other Albaquults.

Typic Albaquults

Fragiaquults

Key to subgroups

GABA. Fragiaquults that:

1. Either do not have mottles or have dominant chroma of 3 or more in some subhorizon between the A or Ap horizon and the fragipan; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthudic Fragiaquults

GABB. Other Fragiaquults that either do not have mottles or have dominant chroma of 3 or more in some subhorizon between the A or Ap horizon and the fragipan.

Aeric Fragiaquults

GABC. Other Fragiaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Fragiaquults

GABD. Other Fragiaquults that do not have an ochric epipedon.

Umbric Fragiaquults

GABE. Other Fragiaquults.

Typic Fragiaquults

Kandiaquults

Key to subgroups

GADA. Kandiaquults that have an ECEC (sum of bases plus 1N KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons to a depth of 150 cm below the soil surface.

Acric Kandiaquults

GADB. Other Kandiaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Kandiaquults

GADC. Other Kandiaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Do not have an ochric epipedon.

Arenic Umbric Kandiaquults

GADD. Other Kandiaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiaquults

GADE. Other Kandiaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiaquults

GADF. Other Kandiaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiaquults

GADG. Other Kandiaquults that have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface.

Aeric Kandiaquults

GADH. Other Kandiaquults that do not have an ochric epipedon.

Umbric Kandiaquults

GADI. Other Kandiaquults.

Typic Kandiaquults

Kanhaplaquults

Key to subgroups

GAEA. Kanhaplaquults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Aquandic Kanhaplaquults

GAEB. Other Kanhaplaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kanhaplaquults

GAEC. Other Kanhaplaquults that:

1. Have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface; *and*

2. Have a mollic or histic epipedon.

Aeric Umbric Kanhaplaquults

GAED. Other Kanhaplaquults that have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface.

Aeric Kanhaplaquults

GAEE. Other Kanhaplaquults that have a mollic or histic epipedon.

Umbric Kanhaplaquults

GAEF. Other Kanhaplaquults.

Typic Kanhaplaquults

Ochraquults

Key to subgroups

GAGA. Ochraquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Ochraquults

GAGB. Other Ochraquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Ochraquults

GAGC. Other Ochraquults that have dominant chroma of 3 or more in one or more subhorizons between the A or Ap horizon and a depth of 75 cm.

Aeric Ochraquults

GAGD. Other Ochraquults.

Typic Ochraquults

Paleaquults

Key to subgroups

GAFA. Paleaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Arenic Plinthic Paleaquults

GAFB. Other Paleaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Do not have an ochric epipedon.
Arenic Umbric Paleaquults

GAFC. Other Paleaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.
Arenic Paleaquults

GAFD. Other Paleaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.
Grossarenic Paleaquults

GAFE. Other Paleaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Plinthic Paleaquults

GAFF. Other Paleaquults that have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface.
Aeric Paleaquults

GAFG. Other Paleaquults that do not have an ochric epipedon.
Umbric Paleaquults

GAFH. Other Paleaquults.
Typic Paleaquults

Plinthaquults

Key to subgroups

GAAA. Plinthaquults that have a CEC of less than 24 cmol(+) per kg of clay (by 1N NH_4OAc pH 7) in the major part of the argillic or kandic horizon, or the major part of

part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhaplohumults, p. 382

GBE. Other Humults that have a clay distribution such that the percentage of clay does not decrease from its maximum amount by 20 percent or more within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Palehumults, p. 383

GBF. Other Humults.

Haplohumults, p. 380

Haplohumults

Key to subgroups

GBEA. Haplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplohumults

GBEB. Other Haplohumults that have the following combination of characteristics in the upper 25 cm or more of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or more or they are artificially drained.

Aquic Haplohumults

GBEC. Other Haplohumults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplohumults

GBED. Other Haplohumults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Haplohumults

GBEE. Other Haplohumults that have an ustic soil moisture regime.

Ustic Haplohumults

GBEF. Other Haplohumults that have a xeric soil moisture regime.

Xeric Haplohumults

GBEG. Other Haplohumults.

Typic Haplohumults

GBDE. Other Kanhaplohumults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kanhaplohumults

GBDF. Other Kanhaplohumults that have an ustic soil moisture regime.

Ustic Kanhaplohumults

GBDG. Other Kanhaplohumults that have a xeric soil moisture regime.

Xeric Kanhaplohumults

GBDH. Other Kanhaplohumults that have an anthropic epipedon.

Anthropic Kanhaplohumults

GBDI. Other Kanhaplohumults.

Typic Kanhaplohumults

Palehumults

Key to subgroups

GBEA. Other Palehumults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Palehumults

GBEB. Palehumults that have the following combination of characteristics in the upper 25 cm or more of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more, and chroma, moist, of 2 of less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or more or there is artificial drainage.

Aquic Palehumults

GBEC. Other Palehumults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Palehumults

GBED. Other Palehumults that have an ustic moisture regime.

Ustic Palehumults

GBEF. Other Palehumults that have a xeric moisture regime.

Xeric Palehumults

GCD. Other Udults that have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhapludults, p. 391

GCE. Other Udults that do not have a lithic or paralithic contact within 150 cm of the mineral soil surface and that have a clay distribution such that the percentage of clay does not decrease from its maximum amount by more than 20 percent within 150 cm of the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Paleudults, p. 393

GCF. Other Udults that have

1. An epipedon that has a color value, moist, of 3 or less in all parts; *and*

2. An argillic horizon that has a color value, dry, of less than 5 and not more than 1 unit higher than the value, moist.

Rhodudults, p. 397

GCG. Other Udults.

Hapludults, p. 387

Fragiudults

Key to subgroups

GCBA. Fragiudults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Fragiudults

GCBB. Other Fragiudults that:

1. Meet *either* of the following:

a. Do not have an argillic or kandic horizon above the fragipan that has some clay skins on both vertical and horizontal surfaces of some structural aggregates; *or*

b. Have an intervening horizon (one or more) between the argillic or kandic horizon and the fragipan that has dominant chroma of 3 or less and that has as much as 3 percent less clay (absolute) than both the overlying argillic or kandic horizon and the underlying fragipan; *and*

2. Have mottles that have chroma of 2 or less within 40 cm of the soil surface; *and*

3. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Plinthaquic Fragiudults

GCBC. Other Fragiudults that:

1. Meet *either* of the following:

a. Do not have an argillic or kandic horizon above the fragipan that has some clay skins on both vertical and horizontal surfaces of some structural aggregates; *or*

b. Have an intervening horizon (one or more) between the argillic or kandic horizon and the fragipan that has dominant chroma of 3 or less and that has as much as 3 percent less clay (absolute) than both the overlying argillic or kandic horizon and the underlying fragipan; *and*

2. Have mottles that have chroma of 2 or less within 40 cm of the soil surface.
Glossaquic Fragiudults

GCBD. Other Fragiudults that have mottles that have chroma of 2 or less above the top of the fragipan and within the upper 25 cm of the argillic or kandic horizon.
Aquic Fragiudults

GCBE. Other Fragiudults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Plinthic Fragiudults

GCBF. Other Fragiudults that meet *either* of the following:

1. Do not have an argillic or kandic horizon above the fragipan that has some clay skins on both vertical and horizontal surfaces of some structural aggregates; *or*

2. Have an intervening horizon (one or more) between the argillic or kandic horizon and the fragipan that has dominant chroma of 3 or less and that has as much as 3 percent less clay (absolute) than both the overlying argillic or kandic horizon and the underlying fragipan.
Glossic Fragiudults

GCBG. Other Fragiudults that have an Ap horizon that has a color value, moist, of 3 or less and has a value, dry, of 5 or less when crushed and smoothed (smoothed with a knife to eliminate shadows), or the A horizon is 15 cm or more thick and its color value, moist, is 3 or less.
Humic Fragiudults

GCBH. Other Fragiudults.
Typic Fragiudults

Hapludults

Key to subgroups

GCGA. Hapludults that:

1. Have a lithic contact within 50 cm of the surface of the mineral soil; *and*

2. Have a discontinuous argillic horizon in each pedon that is interrupted by ledges of bedrock.

Ruptic-Lithic-Entic Hapludults

GCGB. Other Hapludults that have a lithic contact within 50 cm of the surface of the mineral soil.

Lithic Hapludults

GCGC. Other Hapludults that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface, to the base of an Ap horizon, or to a depth within 25 cm of the soil surface; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Hapludults

GCGD. Other Hapludults that have a texture that is loamy fine sand or coarser throughout the argillic horizon or have an argillic horizon that has lamellae within the upper 25 cm.

Psammentic Hapludults

GCGE. Other Hapludults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Hapludults

GCGF. Other Hapludults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Hapludults

GCGG. Other Hapludults that have the following combination of characteristics in the upper 60 cm of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less, and also mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or artificial drainage.

Aquic Hapludults

GCGH. Other Hapludults that have an Ap horizon that has a color value, moist, of 3 or less and has a value, dry, of 5 or less when crushed and smoothed; or the A horizon is 15 cm or thicker and its color value, moist, is 3 or less.

Humic Hapludults

GCGI. Other Hapludults that have an argillic horizon 25 cm or less thick.

Ochreptic Hapludults

GCGJ. Other Hapludults.

Typic Hapludults

Kandiudults

Key to subgroups

GCCA. Kandiudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

3. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthaquic Kandiudults

GCCB. Other Kandiudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied

or more subhorizons within a depth of 150 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Acrudoxic Plinthic Kandiudults

GCCI. Other Kandiudults that have an ECEC (sum of bases plus 1N KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.
Acrudoxic Kandiudults

GCCJ. Other Kandiudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Plinthaquic Kandiudults

GCCK. Other Kandiudults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage.
Aquandic Kandiudults

GCCL. Other Kandiudults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandiudults

GCCM. Other Kandiudults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage.

Aquic Kandiudults

GCCN. Other Kandiudults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiudults

GCCO. Other Kandiudults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kandiudults

GCCP. Other Kandiudults that have a sombric horizon within 150 cm of the soil surface.

Sombric Kandiudults

GCCQ. Other Kandiudults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is 1 unit or less higher than the value, moist.

Rhodic Kandiudults

GCCR. Other Kandiudults.

Typic Kandiudults

Kanhapludults

Key to subgroups

GCDA. Kanhapludults that have a lithic contact within 50 cm of the soil surface.

Lithic Kanhapludults

GCDB. Other Kanhapludults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kanhapludults

GCDH. Other Kanhapludults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kanhapludults

GCDI. Other Kanhapludults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kanhapludults

GCDJ. Other Kanhapludults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is one unit or less higher than the value, moist.

Rhodic Kanhapludults

GCDK. Other Kanhapludults.

Typic Kanhapludults

Paleudults

Key to subgroups

GCEA. Paleudults that have a horizon that is above the argillic horizon whose lower boundary is deeper than 18 cm and that meets all requirements for a spodic horizon except that the horizon is intermittent.

Spodic Paleudults

GCEB. Other Paleudults that:

1. Have texture that is loamy fine sand or coarser in all parts of the argillic horizon, or the argillic horizon has lamellae in some or all parts of the upper 100 cm; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more

c dd h a h t f2 p f d c h f h s n

or the argillic horizon has lamellae in some or all parts of the upper 100 cm.

Psammentic Paleudults

GCED. Other Paleudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

   a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

   b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

3. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthaquic Paleudults

GCEE. Other Paleudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

   a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

   b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Paleudults

GCEF. Other Paleudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

GCEL. Other Paleudults that:

1. Have at least one subhorizon in the argillic horizon and within 125 cm of the soil surface that has all the properties of a fragipan except that it is brittle in 40 to 60 percent of the volume; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or artificial drainage.

Fragiaquic Paleudults

GCEM. Other Paleudults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or artificial drainage.

Aquic Paleudults

GCEN. Other Paleudults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Paleudults

GCEO. Other Paleudults that have at least one subhorizon in the argillic horizon and within 125 cm of the soil surface that has all the properties of a fragipan except that it is brittle in 40 to 60 percent of the volume.

Fragic Paleudults

GCEP. Other Paleudults that have, throughout the upper 100 cm of the argillic horizon, a color value, moist, of 3 or less and a color value, dry, 1 unit or less higher than the value, moist, and do not have mottles with chroma of 3 or more.

Rhodic Paleudults

GCEQ. Other Paleudults.

Typic Paleudults

Plinthudults

Plinthudults are the Udults that have plinthite that forms a continuous phase or constitutes more than half the matrix of some subhorizon in the upper 150 cm of the soil.

Rhodudults

Key to subgroups

GCFA. Rhodudults that have a lithic contact within 50 cm of the soil surface.

Lithic Rhodudults

GCFB. Other Rhodudults that have texture that is loamy fine sand or coarser throughout the argillic horizon.

Psammentic Rhodudults

GCFC. Other Rhodudults.

Typic Rhodudults

USTULTS

Key to great groups

GDA. Ustults that have plinthite that forms a continuous phase or that constitutes more than half the volume of some subhorizon within 150 cm of the soil surface.

Plinthustults, p. 403

GDB. Other Ustults that

1. Have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

2. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the soil surface; *and*

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiustults, p. 399

GDC. Other Ustults that have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhaplustults, p. 401

GDFF. Other Haplustults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Haplustults

GDFG. Other Haplustults that have CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if the argillic horizon is thicker than 100 cm.

Kanhaplic Haplustults

GDFH. Other Haplustults.

Typic Haplustults

Kandiustults

Key to subgroups

GDBA. Kandiustults that have an ECEC (sum of bases plus KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.

Acrustoxic Kandiustults

GDBB. Other Kandiustults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kandiustults

GDBC. Other Kandiustults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Kandiustults

GDBD. Other Kandiustults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiustults

during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kandiustults

GDBJ. Other Kandiustults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is one unit or less higher than the value, moist.

Rhodic Kandiustults

GDBK. Other Kandiustults.

Typic Kandiustults

Kanhaplustults

Key to subgroups

GDCA. Kanhaplustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplustults

GDCB. Other Kanhaplustults that have an ECEC (sum of bases plus KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.

Acrustoxic Kanhaplustults

GDCC. Other Kanhaplustults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kanhaplustults

GDCD. Other Kanhaplustults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kanhaplustults

GDCE. Other Kanhaplustults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. When neither irrigated nor fallowed to store moisture:

Chapter 15

Vertisols

KEY TO SUBORDERS

EA. Vertisols that have a thermic, mesic, or frigid soil temperature regime and, unless irrigated, have cracks that open and close once each year and remain open for 60 consecutive days or more in the 90 days following the summer solstice in more than 7 out of 10 years but that are closed for 60 consecutive days or more during the 90 days following the winter solstice.

Xererts, p. 410

EB. Other Vertisols that, unless irrigated, have in most years cracks that either remain open throughout the year or are closed for less than 60 consecutive days at a period when the soil temperature at a depth of 50 cm is continuously higher than 8°C.

Torrerts, p. 407

EC. Other Vertisols that have cracks that open and close one or more times during the year in most years but do not remain open for as many as 90 cumulative days in most years.

Uderts, p. 408

ED. Other Vertisols.

Usterts, p. 409

TORRERTS

Key to subgroups

EBAA. Torrerts that:

1. Have a surface horizon 30 cm or more thick with a color value of 3 or less, moist, in half or more of each pedon; *and*

2. Have prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix within 100 cm of the soil surface.

Paleustollic Torrerts

EBAB. Other Torrerts that have a surface horizon 30 cm or more thick with a color value of 3 or less, moist, in half or more of each pedon.

Mollic Torrerts

EBAC. Other Torrerts that have prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix within 100 cm of the soil surface.

Argidic Torrerts

EBAD. Other Torrerts.

Typic Torrerts

UDERTS

Key to great groups

ECA. Uderts that have a chroma, moist, of 2 or more dominant in the matrix of some subhorizon in the upper 30 cm in more than half of each pedon.

Chromuderts, p. 408

ECB. Other Uderts.

Pelluderts, p. 408

Chromuderts

Key to subgroups

ECAA. Chromuderts that:

1. Have distinct or prominent mottles within 50 cm of the soil surface in more than half of each pedon (the terms refer to contrast, not to size of the mottles); *and*

2. Have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Aquentic Chromuderts

ECAB. Other Chromuderts that have distinct or prominent mottles within 50 cm of the soil surface in more than half of each pedon (the terms refer to contrast, not to size of the mottles).

Aquic Chromuderts

ECAC. Other Chromuderts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon or the horizon with color value or 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Chromuderts

ECAD. Other Chromuderts.

Typic Chromuderts

Pelluderts

Key to subgroups

ECBA. Pelluderts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Pelluderts

ECBB. Other Pelluderts.

Typic Pelluderts

with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Udorthentic Pellusterts

EDBB. Other Pellusterts that have cracks that remain open for 150 or less cumulative days during each year, or have a mean annual soil temperature that is less than 15°C.

Udic Pellusterts

EDBC. Other Pellusterts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Pellusterts

EDBD. Other Pellusterts that have within 100 cm of the soil surface prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix.

Paleustollic Pellusterts

EDBE. Other Pellusterts.

Typic Pellusterts

XERERTS

Key to great groups

EAA. Xererts that have a dominant chroma, moist, of 2 or more in the matrix of some subhorizon in the upper 30 cm in more than half of each pedon.

Chromoxererts, p. 410

EAB. Other Xererts.

Pelloxererts, p. 411

Chromoxererts

Key to subgroups

EAAA. Chromoxererts that have distinct or prominent mottles (these terms refer to contrast, not size) within 50 cm of the soil surface in more than half of each pedon.

Aquic Chromoxererts

EAAB. Other Chromoxererts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Chromoxererts

EAAC. Other Chromoxererts that have, within 100 cm of the soil surface, prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix.

Palexerollic Chromoxererts

EAAD. Other Chromoxererts.

Typic Chromoxererts

Pelloxererts

Key to subgroups

EABA. Pelloxererts that have in one or more subhorizons within a depth of 100 cm a chroma, either dry or moist, of 2 or more, or have between 30 cm and 100 cm neither distinct or prominent mottles, nor concretions that are due to segregated iron or manganese.

Chromic Pelloxererts

EABB. Other Pelloxererts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Pelloxererts

EABC. Other Pelloxererts.

Typic Pelloxererts

SI Units Conversion Table

CEC and ECEC:

1 meq/100 g soil = 1 cmol(+) per kg soil

Conductivity:

1 mmho/cm = 1 dS per m

Pressure:

15-bar water = 1500 kPa water retention

1/3-bar water = 33 kPa water retention

unlike the assumed parent material of the buried soil. The symbol is not used in organic soils or to separate an organic layer from a mineral layer.

c *Concretions or nodules*

This symbol is used to indicate a significant accumulation of concretions or of nodules. Cementation is required. The cementing agent is not specified except it cannot be silica. This symbol is not used if concretions or nodules are dolomite or calcite or more soluble salts, but it is used if the nodules or concretions are enriched in minerals that contain iron, aluminum, manganese, or titanium. Their consistence is specified in the horizon description.

d *Dense unconsolidated sediments or materials*

This symbol is used to indicate naturally occurring or manmade, unconsolidated sediments or materials with high bulk density, such as dense basal till, plow pans and other mechanically compacted zones. The layer is root restrictive and roots do not enter except along fracture planes.

e *Organic material of intermediate decomposition*

This symbol is used with "O" to indicate organic materials of intermediate decomposition. Rubbed fiber content is 17 to 40 percent of the volume. Usually occurs in soils saturated for prolonged periods; however, can occur in soils not saturated for prolonged periods.

f *Frozen soil*

This symbol is used to indicate that the horizon or layer contains permanent ice. Symbol is not used for seasonally frozen layers or for "dry permafrost" (material that is colder than 0°C but does not contain ice).

g *Strong gleying*

This symbol is used to indicate either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved a reduced state. Most of the affected layers have low chroma and many are mottled. The low chroma can be the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed. Symbol "g" is not used for soil materials of low chroma, such as some shales or E horizons, unless they have a history of wetness. If "g" is used with "B," pedogenic change in addition to gleying is implied. If no other pedogenic change in addition to gleying has taken place, the horizon is designated Cg.

h *Illuvial accumulation of organic matter*

This symbol is used with "B" to indicate the accumulation of illuvial, amorphous, dispersible organic matter-sesquioxide complexes if the sesquioxide component is dominated by aluminum

cementation is continuous or nearly continuous, "qm" is used.

r *Weathered or soft bedrock*

This symbol is used with "C" to indicate layers of soft bedrock or saprolite, such as weathered igneous rock, partly consolidated soft sandstone, siltstone, and shale. Roots cannot enter except along fracture planes. The material can be dug with a spade.

s *Illuvial accumulation of sesquioxides and organic matter*

This symbol is used with "B" to indicate the accumulation of illuvial, amorphous, dispersible organic matter-sesquioxide complexes if both the organic matter and sesquioxide components are significant and the value and chroma of the horizon is more than 3. The symbol is also used in combination with "h" as "Bhs" if both the organic matter and sesquioxide components are significant and the value and chroma are approximately 3 or less.

ss *Presence of slickensides*

This symbol is used to indicate the presence of slickensides. Slickensides result directly from swelling of clay minerals and shear failure, commonly at angles of 20 to 60° above horizontal. They are indicators that other vertic characteristics such as wedge-shaped peds and surface cracks may be present.

t *Accumulation of silicate clay*

This symbol is used to indicate an accumulation of silicate clay either by illuviation into the horizon or by formation and subsequent translocation within the horizon, or both. The clay can be in the form of coatings on ped surfaces or in pores, lamellae, or bridges between mineral grains.

v *Plinthite*

This symbol is used to indicate the presence of iron-rich, humus-poor, reddish material that is firm or very firm when moist and that hardens irreversibly when exposed to the atmosphere and to repeated wetting and drying. These properties are characteristic of plinthite.

w. *Development of color or structure*

This symbol is used with "B" to indicate development of color or structure, or both, with little or no apparent illuvial accumulation of material. It should not be used to indicate a transitional horizon.

x *Fragipan character*

This symbol is used to indicate genetically developed firmness, brittleness, or high bulk density. These features are characteristic of fragipans, but some

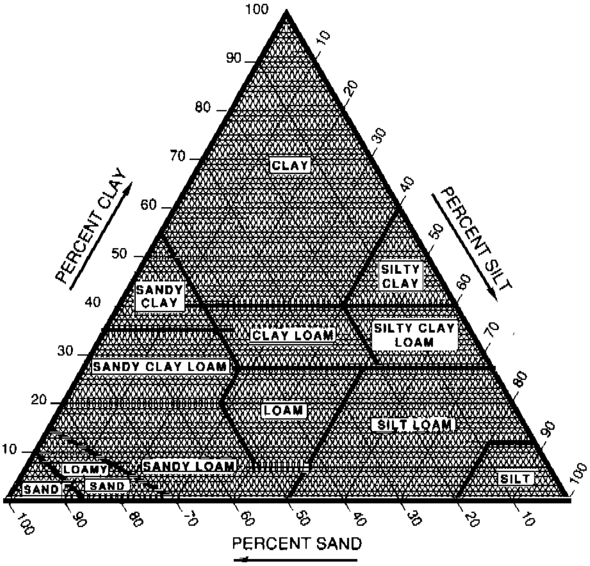

Chart showing the percentages of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes.